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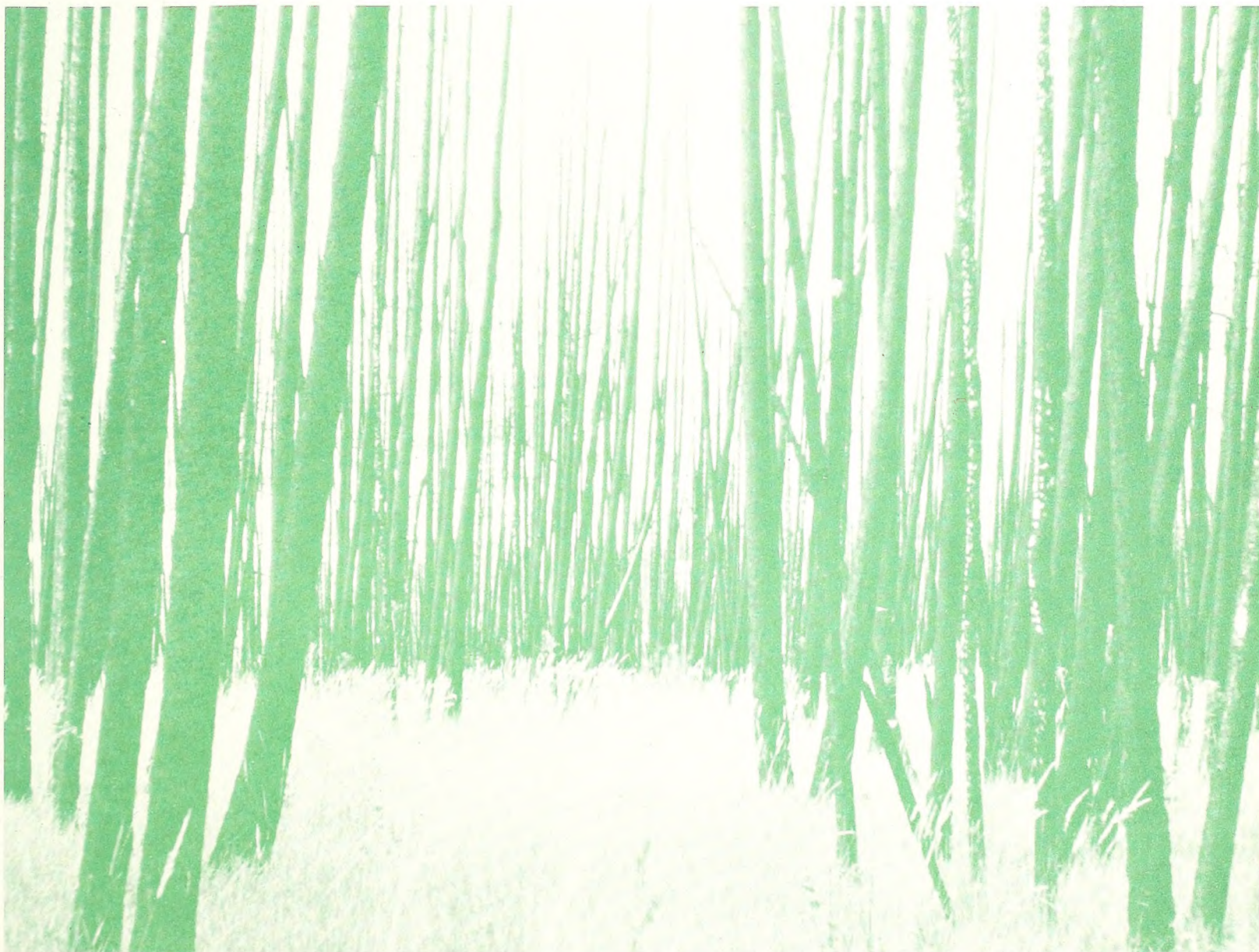


Early Postfire Revegetation in a Western Montana Douglas-fir Forest

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RESEARCH SUMMARY

A severe stand-destroying wildfire burned a 1,200-acre (486 ha) second-growth Douglas-fir forest (primarily Douglas-fir/ninebark habitat type) near Missoula, Mont., in July 1977. Most of the burned area was aerially seeded with exotic grasses during November 1977 while covered with snow.

Seeded orchardgrass and the native pinegrass are the most competitive species after 5 years. Orchardgrass is dominant in most areas. Shrubs have achieved dominance in most ravines and on some upland sites. On many upland sites, however, secondary colonization by shrubs will be necessary for a well-defined shrub stage to become established. The recovery of understory plants has been much more rapid in the ravines than on any upland sites. Tree regeneration is presently scarce, suggesting that reforestation will be slow.

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INTRODUCTION

The wildfire that burned part of Pattee Canyon (fig. 1) on July 16 and 17, 1977, was a fast-spreading, intense crown fire. It burned 1,200 acres (486 ha) of land consisting mainly of Douglas-fir forest in the *Pseudotsuga menziesii*/*Physocarpus malvaceus* h.t. (PSME/PHMA; Douglas-fir/ninebark) as described by Pfister and others (1977). The Pattee Canyon burn presented an opportunity to study vegetative recovery following a severe wildfire in the extensive, interior Douglas-fir forest of western Montana. Such studies began in spring 1978.

THE STUDY AREA

Location

The Pattee Canyon drainage is located in the north end of the Sapphire Mountains in west-central Montana just southeast of Missoula. Pattee Creek drains the area and is fed by more than a dozen first- to third-order tributaries draining the side ridges. During spring runoff these small first- and second-order streams may flow overland their entire length, but in summer they become intermittent.

The fire burned a portion of the north-facing slope of the canyon lying below Mount Dean Stone (fig. 1). Land holdings in the area are divided among private, State, and Federal ownerships (fig. 1).

Geology and Soils

Bedrock in Pattee Canyon consists of quartzites and argillites of the Belt Series. Pattee Canyon was not glaciated during the Pleistocene ice ages. Glacial Lake Missoula, however, extended into Pattee Canyon (Alden 1953).

Soils in the study area are Tevis series with Mitten-Tewis complex on some upper slopes (L. T. Stem, USDA Soil Conservation Service, personal communication, 1980). These gravely loam inceptisols are colluvial soils derived from argillite and quartzite. The presence of an andic layer differentiates soils of the Mitten-Tewis complex from those of the Tevis series.

Climate

Climate in the Missoula area is strongly influenced by the Pacific Ocean where most of the area's weather originates. By the time the Pacific air masses reach Missoula, however, much of the moisture has been released. According to the National Weather Service, Missoula receives an average of 12 to 15 inches (305 to 381 mm) precipitation annually. Most of the moisture in Missoula and Pattee Canyon falls as snow during the winter or as rain showers during May and June. Midsummers are usually dry.

Pattee Canyon receives more moisture than Missoula itself. National Weather Service data from the Missoula Airport station and from a climatological station located on the north side of Pattee Canyon at about 3,740 feet (1 140 m) elevation are summarized in table 1. This comparison indicates that precipitation amounts in Pattee Canyon are generally higher than those recorded at the Missoula Airport station. Based on these data, Pattee Canyon gets an average of 85 percent greater precipitation than Missoula in spring and about 30 to 40 percent more during other seasons.

Vegetation

During a geographical study of Pattee Canyon (circa 1975) Bruce Bugbee (1981; personal communication) described habitat types in terms of Pfister and others (1972), preliminary forest habitat types of western Montana. The most widespread habitat type in the burned area was a *Pseudotsuga menziesii*/*Physocarpus malvaceus* h.t., *Physocarpus malvaceus* phase (PSME/PHMA-PHMA; Douglas-fir/ninebark, ninebark phase). *Pseudotsuga menziesii*/*Physocarpus malvaceus* h.t., *Calamagrostis rubescens* phase (PSME/PHMA-CARU; Douglas-fir/ninebark, pinegrass phase) occupied drier slopes and Douglas-fir scree occurred on the driest ridges. The upper slopes near the ridge were *Pseudotsuga menziesii*/*Vaccinium globulare* h.t., (PSME/VAGL; Douglas-fir/blue huckleberry) and, extending down the ravines, the coolest, moist areas were occupied by *Abies lasiocarpa*/*Linnaea borealis* h.t. (ABLA/LIBO; subalpine fir/twinflower).



Figure 1.—The Pattee Canyon fire area near Missoula, Mont., as shown by a 1972 aerial photograph.

Table 1.—Comparison of precipitation data from Missoula Airport Station and Pattee Canyon climatological station (source: National Weather Service Climatological Data)

Month	Precipitation amount					
	1976		1977		1978	
	Missoula Airport	Pattee Canyon	Missoula Airport	Pattee Canyon	Missoula Airport	Pattee Canyon
	-----Inches (millimeters)-----					
Jan.	0.90 (22.9)	1.03 (26.2)	0.66 (16.8)	0.80 (20.3)	1.15 (29.2)	1.46 (37.1)
Feb.	1.04 (26.4)	1.47 (37.3)	.18 (4.6)	.06 (1.5)	.66 (16.8)	1.49 (37.8)
Mar.	.40 (10.2)	.65 (16.5)	.98 (24.9)	1.50 (38.1)	.67 (17.0)	1.16 (29.5)
Apr.	.94 (23.9)	2.02 (51.3)	.08 (2.0)	.14 (3.6)	1.08 (27.4)	
May	.79 (20.1)	1.36 (34.5)	2.13 (54.1)	3.42 (86.9)	1.98 (50.3)	
June	1.52 (38.6)	3.19 (81.0)	.66 (16.8)	1.08 (27.4)	.77 (19.6)	
July	1.20 (30.5)	1.50 (38.1)	.72 (18.3)	.94 (23.9)	.57 (14.5)	
Aug.	.88 (22.4)	1.45 (36.8)	1.28 (32.5)	1.33 (33.8)	1.11 (28.2)	
Sept.	.58 (14.7)	.85 (21.6)	1.67 (42.4)	1.92 (48.8)	1.78 (45.2)	
Oct.	.33 (8.4)	.49 (12.4)	.72 (18.3)	1.01 (25.7)	.01 (.3)	
Nov.	.22 (5.6)	.63 (16.0)	1.02 (25.9)	1.58 (40.1)	1.00 (25.4)	
Dec.	.25 (6.4)	.33 (8.4)	2.88 (73.2)	4.16 (105.7)	.99 (25.1)	
Total	9.04 (229.9)	14.96 (380.2)	12.97 (329.7)	17.93 (455.7)	11.75 (298.7)	

Schuler's 1968 vegetation study in Pattee Canyon included some stands within and near the area subsequently burned in 1977. His original field data for these stands, as well as examination of pre-1977 aerial photographs and the fire-killed forest (fig. 2) indicate that much of the preburn forest was composed of dense, stagnating, pole-sized Douglas-fir (*Pseudotsuga menziesii*). Western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), and above 4,600 feet (1 402 m), lodgepole pine (*Pinus contorta*) were also present. The north slopes of Pattee Canyon have been roaded and subjected to selective logging throughout the 1890-1960 period on both Federal and private lands (fig. 1).

The general vegetation pattern of Pattee Canyon demonstrates a trend toward increasingly more mesic species as one proceeds up the canyon. Slope exposure is an added influence, with more mesic species occurring on the north-facing slopes of the canyon.

A description of prefire vegetation was also obtained from observation of unburned stands adjacent to the burned area. One such stand (ravine stand 7) is in a relatively dry ravine with no established creek bed nor sign of annual overland flow. A dense overstory was composed of about 50 percent Douglas-fir, 40 percent



Figure 2.—Fire-killed stand of dense pole-sized trees in Pattee Canyon. This stand had been predominantly Douglas-fir.

western larch and 10 percent ponderosa pine. Tree ring counts indicated a stand age of about 70 to 80 years. The understory was layered. The tall shrub layer consisted of Rocky Mountain maple (*Acer glabrum*) and some serviceberry (*Amelanchier alnifolia*). Below these arborescent shrubs were lower shrubs including ninebark (*Physocarpus malvaceus*) and white spirea (*Spiraea betulifolia*), with a sparse herbaceous layer of heartleaf arnica (*Arnica cordifolia*), pinegrass (*Calamagrostis rubescens*), sidebells shinleaf (*Pyrola secunda*), western rattlesnake plantain (*Goodyera oblongifolia*), and western meadowrue (*Thalictrum occidentale*). There was also a well developed moss layer and a large amount of litter on the forest floor.

Fire Frequency

A fire history study for the north slope of Pattee Canyon, including the area burned in 1977, is in progress (Habeck, J. R.; unpublished data). Fire scars, mostly from ponderosa pine snags and stumps, provide the basis for the fire chronology. Nine samples, with five to nine fire scars each, have been analyzed using the methods described by Arno and Sneek (1977). Between approximately 1700 and 1900, the sampled area of Pattee Canyon experienced fires severe enough to scar the trees at an average interval of 15.8 years. Some fires scarred only one of the sample trees and thus may have been limited in extent or may have burned with such a low severity as not to scar other trees. It appears to have been more common for fires to cover large areas of the north slope or even the entire north slope because trees 2 or more miles apart exhibit similar fire dates based on a preliminary analysis of the data. During the century prior to settlement, 1780 to 1880, widespread fires occurred on an average of one per decade. The fire frequency in Pattee Canyon compares well with the mean fire-free interval of 13 years for the period 1600–1910 on similar sites in the neighboring Bitterroot Mountains (Arno 1980).

Prior to settlement, fires in western Montana resulted from summer lightning storms and Indian ignitions (Barrett 1981; Barrett and Arno 1982). Barrett's study and Arno's earlier (1976) study suggest that most of these fires were ground fires of low-to-moderate severity and frequent fires precluded heavy accumulations of fuel.

Based on fire scar analysis, tree aging, and an interpretation of the original Federal land survey records (Habeck, J. R.; unpublished data), the presettlement forest in Pattee Canyon appears to have been maintained by fire as an open, nearly parklike forest, with ponderosa pine on drier ridges, western larch in moist areas, and a scattering of mature Douglas-fir. Fire was effectively eliminated from Pattee Canyon throughout much of the 1900–77 period; selective logging removed the largest trees; and the open forests changed to densely stocked, closed-canopied stands easily capable of supporting high intensity crown fires.

The Fire

The Pattee Canyon fire started in dry grass near the west end of Pattee Canyon at about 4:20 in the afternoon July 16, 1977. Fire behavior was influenced by extreme fire weather: high temperature, low relative humidity, and strong, gusty winds. The Fire Danger Rating was, consequently, very high. The wind-driven fire spread quickly up the grassy slope and into adjacent conifers, where it crowned almost immediately. The fire then began its main run up Pattee Canyon toward the southeast with its smoke column pushed horizontal. The fire was extremely intense at this point and numerous spot fires started far ahead of the front (Jerry Williams, Montana State Division of Forestry, 1981; personal communication). Self-induced winds, along with the fire's direction up the hill, kept the fire away from the floor of the canyon and the many homes located there. As the fire burned across the north slope ravines, each ravine in turn acted as a chimney, funneling the fire up the ravine. Near the upper ridge the fire met gradient winds blowing the fire back upon itself. When the fire reached its eastern boundary, it met the developed spot fires. These spot fires then became backfires. The fire completed its main run by 5:15 p.m. (fig. 3). Fire suppression efforts were then directed at putting out spot fires. The fire was declared contained the second day (July 17) and controlled the third day (July 18).

The fire burned about 1,200 acres (486 ha) and destroyed six homes (Fischer and Books 1977). It burned with greatest severity across sections 4 and 3 and the lower two-thirds of section 10 (fig. 3), with fire whirls in the western half of sections 3 and 10. In the southern (upper) portion of section 10 fire treatment was inconsistent, with vegetation in some sectors burned severely. In other areas the overstory was killed but the needles and small twigs on the trees were not consumed and the duff was not entirely removed from the soil. In section 11 the fire consisted of numerous spot fires, which collectively were much less uniform and less intense, leaving partially scorched crowns in some areas while confined to the ground elsewhere.

A postfire analysis of fire intensity in Pattee Canyon (Rothermel 1977) was divided into two parts: probable fire behavior in the grazed grass at the ignition point, and probable fire behavior in surface fuels under the timber (table 2). Crown fire intensity was not assessed but is estimated to have been at least tenfold that of the surface fire (Rothermel 1977).

Postfire Treatments

Immediately following the fire a team of Federal and State specialists inspected the burn and prescribed seeding with grass as a watershed rehabilitation measure. Aerial seeding was accomplished under the direction of USDA Soil Conservation Service during November while the area was snow covered. One private parcel on the west side of the fire was not seeded at the owner's request (fig. 1). The seed mixture was varied according to elevation (table 3).

During the winter of 1977-78, landowners in the lower portion of the burn conducted salvage logging to remove dead trees. Such logged areas were avoided for study purposes in order to prevent confusing fire effects with effects of tree removal and mechanical scarification. The "study area" then is limited to the burned area in sections 10 and 11 (fig. 3).

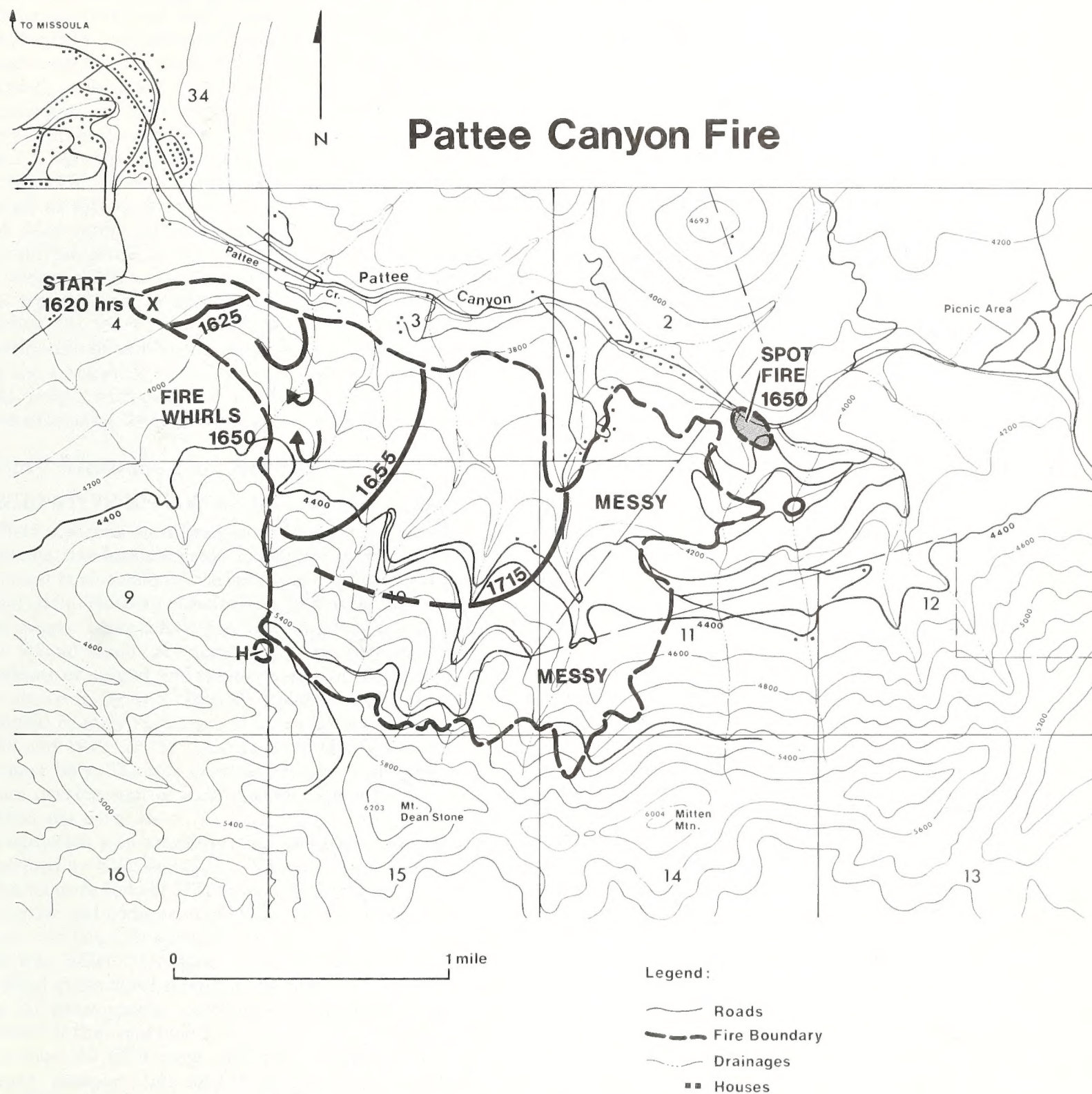


Figure 3.—Fire progress and area burned from start at about 4:20 p.m. to completion of its main run at 5:15 p.m., July 16, 1977.

Table 2.—Calculated fire behavior for Pattee Canyon Fire, July 16, 1977
(Rothermel 1977)

Fuel type	Calculated fire behavior		
	Rate of spread	Flame length	Fireline intensity
	<i>Ft/min (m/min)</i>	<i>Ft (m)</i>	<i>BTU/ft/sec (Cal/cm²/sec)</i>
Grazed grass	103 (31.4)	4.5 (1.4)	151 (41.0)
Forest floor	31 (9.5)	9.5 (2.9)	759 (205.9)

Table 3.—Commercial hybrid grasses seeded, and seeding rates, for Pattee Canyon burn; the 4,400-foot level is indicated on figure 3

Commercial grass species	Elevation	
	Below 4,400 ft (1 340 m)	Above 4,400 ft (1 340 m)
	-----Lb/acre(kg/ha)-----	
Latar orchard grass (<i>Dactylis glomerata</i>)	4.0 (4.5)	4.0 (4.5)
Luna pubescent wheatgrass (<i>Agropyron trichophorum</i> and <i>A. intermedium</i>)	19.0 (21.3)	
Kenmount tall fescue (<i>Festuca arundinaceae</i>)		8.0 (9.0)
Manchar smooth brome (<i>Bromus inermis</i>)		14.0 (15.7)

THE STUDIES

Since 1977, different research scientists have conducted four separate but related studies in the Pattee Canyon burn. The studies had two common objectives: to examine the vegetative recovery and to determine the effect of seeded grass on that recovery.

Two parallel studies of the initial vegetative recovery were established in spring 1978, one in upland areas (Anderson 1979) and one in ravines (Keller [Crane] 1980). Similar field methods were used for both studies, making direct comparisons possible. Plots were permanently marked, to facilitate long-term studies of vegetation recovery in the burn. These two initially separate studies were combined during the 1982 field season. Fuel loading was also studied in both upland and ravine areas during 1978, 1979, and 1980 using plots in the same stands as the vegetation studies.

A third study evaluated the response of ground bryophytes and lichens to the fire. The study was begun in summer 1978 using the same permanently marked plot transects as the upland and ravine vegetation studies. The fourth study, aimed at describing the distribution of conifer regeneration, was conducted during the summer of 1980. This study used a systematic field design, with plots set equidistant along contour lines extending through the burn at specific elevations.

Study Methods and Results

VEGETATIVE RECOVERY ON UPLAND SITES

Field methods on upland sites. Preferential stand selection was based on site homogeneity, as judged by physical environmental variables and remnants of prefire vegetation. Thirteen stands were located on open slopes and ridges. Table 4 lists physical variables for all stands. The upland stands are numbered 15 through 27. The locations of upland and ravine stands in the burned area are shown in figure 4. Initially upland stands were sampled in early summer and again in late summer of 1978 and 1979. In 1982 stands were sampled in late summer only. The late summer samples represent maximum development of most species. Appendix A-1 lists upland site cover data.

Vegetation was sampled using the nested plot design described by Stickney (1980). Vascular plant nomenclature follows Hitchcock and Cronquist (1973). Scientific and common names for species mentioned herein are listed in appendix D.

It was difficult to determine cover values for individual grass species during the first year following the fire. All grass species were therefore recorded simply as "grass" if the combined grass cover was one-sixth plot or greater. In 1979 some data were recorded in a "grass" category, but data for principal species were recorded by species. During the 1982 remeasurement all grass data were recorded by species. Those species with less than one-sixth plot cover were recorded as miscellaneous vegetation if they collectively totaled one-sixth cover rather than having a separate category for grasses (Stickney 1980).

Table 4.—Sample stand physical data (see figure 4 for stand location within fire area)

Stand	Elevation		Exposure	Slope
	Feet	Meters	Degrees	Degrees
1	3,970	1 210	312	9
2	4,060	1 240	355	9
3	3,940	1 200	10	10
4	4,030	1 230	35	9
5	4,170	1 270	55	11
6	4,280	1 305	50	15
7	4,430	1 350	360	20
8	4,720	1 440	60	32
9	4,910	1 500	55	33
10	4,790	1 460	55	33
11	4,430	1 350	15	15
12	4,560	1 390	20	15
13	4,690	1 430	360	30
14	4,230	1 290	25	11
15	4,100	1 250	330	8
16	4,400	1 340	330	9
17	4,100	1 250	345	17
18	4,300	1 310	345	18
19	4,300	1 310	350	31
20	4,700	1 430	277	34
21	4,800	1 460	325	26
22	5,100	1 550	350	26
23	5,050	1 540	317	22
24	5,100	1 550	307	33
25	5,600	1 710	333	19
26	5,250	1 600	360	38
27	5,100	1 550	338	27

Analysis of upland site data. The data from the permanent vegetative sample plots were analyzed by the USDA Forest Service's LOGBURN computer program (LOGBURN was created by L. Jack Lyon in 1966. It is on system at Intermountain Forest and Range Experiment Station, Missoula, Mont.). Cover values for each species from all plots were averaged for each stand and converted to a 0.01 ha standard. Because this standard equals 100 m², the values given for cover in the tables may be read directly as either meters squared per hundredth hectare or as percentage of ground covered. The volume of space occupied by each species was determined by multiplying the cover by the representative height. Volumes were averaged and converted to a meter cubed per hundredth hectare standard. Because the cover and volume data are converted to a standard based in part on the size of the plot in which the plants were measured, there may be rare cases in which cover and volume values appear to go down as the plant grows in height and is measured in the next larger plot. Tree data are summarized as basal area in decimeters squared per hundredth hectare.

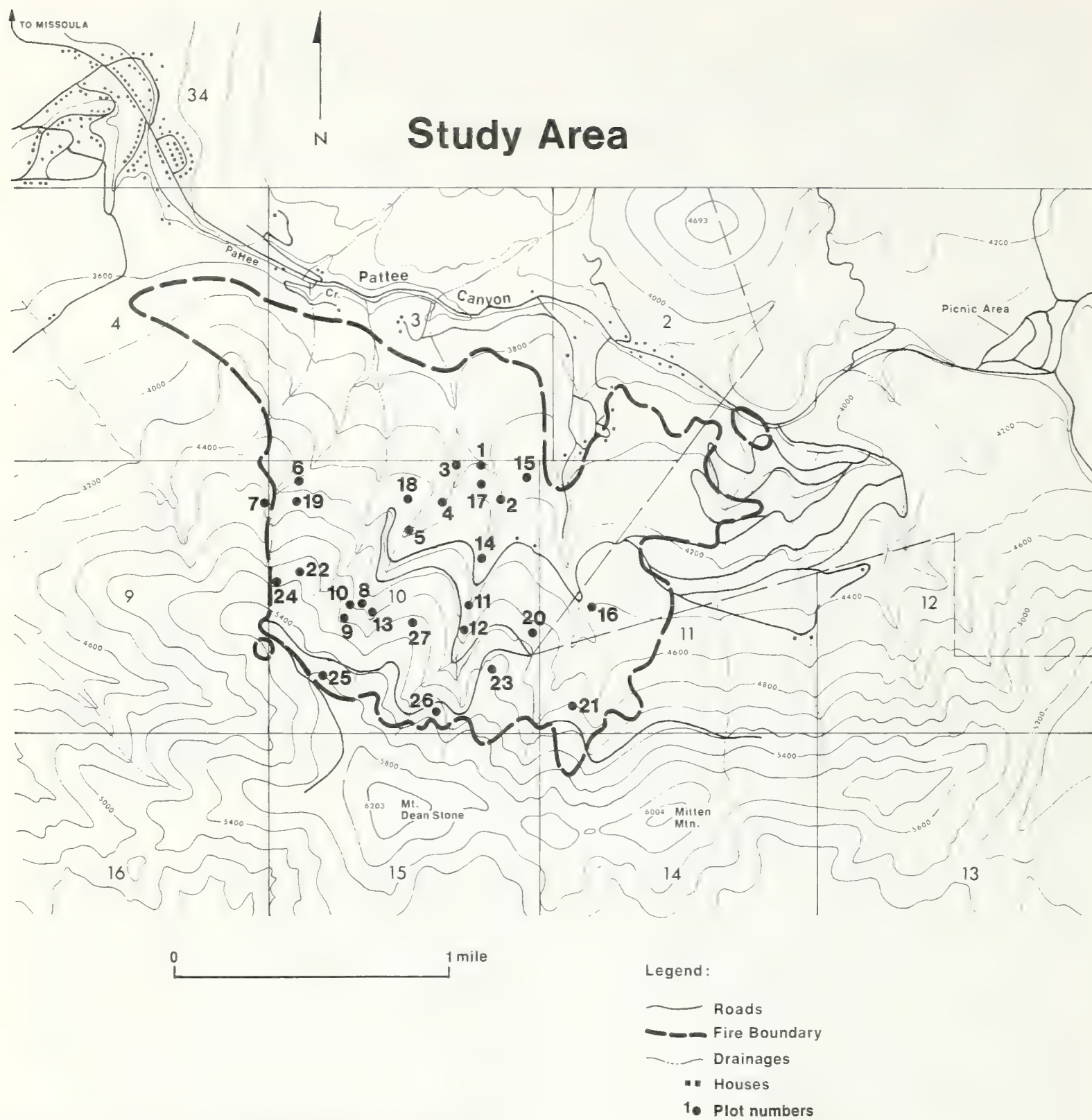


Figure 4.—Study area map. Numbers refer to stand plots.

Study results on upland sites. Table 5 shows the general pattern of recovery for upland seral community life-forms and the most important species within each life-form. Shrub cover and volume are low for the first 5 years since shrub resprouts are scattered on most upland sites. Stand 19 represents one of the exceptions to this trend. Shrub seedlings were noted in many stands during the summer of 1982. Herbaceous species, particularly grasses, dominate most sites.

Figure 5 shows the pattern of grass development, using the mean cover and volume for all upland stands. Pinegrass bloomed profusely during the summer of 1978 and somewhat less energetically in 1979. Subsequent seedling establishment observed in 1979 and 1980 coupled with vegetative spread account for the increase in pinegrass. The reasons for the decline of orchardgrass are unclear.

Table 5.—Upland cover and volume means for stands 16 through 27. Stand 15 was not included in these means because it was disturbed by grazing in 1982. Height data were not taken for grasses in 1978

	Cover			Volume		
	1978	1979	1982	1978	1979	1982
	Percent or m ² /0.01 ha			-----m ³ /0.01 ha-----		
Shrubs:						
<i>Physocarpus malvaceus</i>	1.3	2.5	4.0	0.4	1.0	2.5
<i>Spiraea betulifolia</i>	.1	1.2	.9	T ¹	.5	.2
<i>Vaccinium globulare</i>	—	.1	1.4	—	T	.2
Total shrubs	1.6	4.6	8.0	.5	1.6	3.6
Grasses:						
<i>Agropyron trichophorum</i>	—	.1	.2	—	.1	.1
<i>Bromus inermis</i>	—	—	.1	—	—	T
<i>Calamagrostis rubescens</i>	.6	3.7	8.5	—	1.4	1.6
<i>Dactylis glomerata</i>	—	16.3	9.5	—	3.8	2.3
<i>Festuca arundinacea</i>	—	—	.1	—	—	T
Total grasses	20.0	24.0	18.5	—	5.3	4.1
Total herbs ²	29.7	29.0	33.5	—	7.1	7.7
Total vascular plants	31.3	33.6	41.5	—	8.7	10.2

¹T = trace.

²May include shrubs under 5 dm tall with less than one-sixth cover in individual plots.

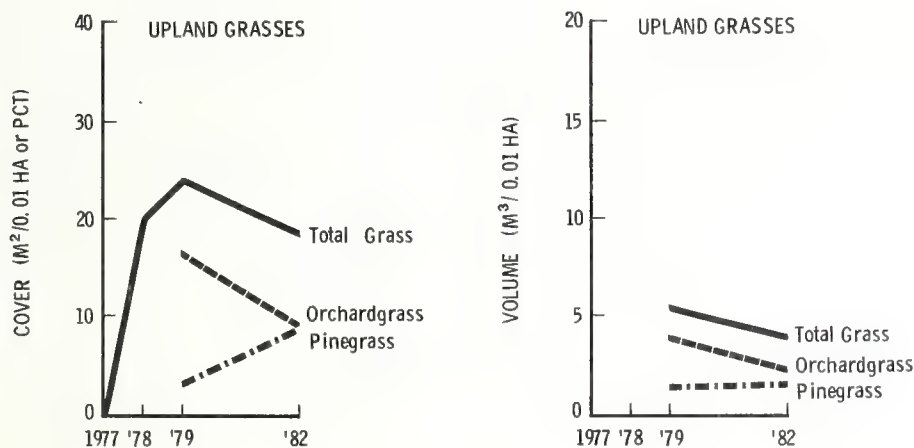


Figure 5.—Cover and volume means for grasses in upland stands. Height measurements were not taken in 1978 for grasses. Solid lines indicate total grass means; dashed lines indicate orchardgrass means; and dashed and dotted lines indicate pinegrass means.

Most of the burned area was aerially seeded; however, one area in the western portion of the burn was not seeded at the request of the landowner. Stand 19 is located in this area and had only a trace of seeded grass in 1978. Other areas without seeded grass were deliberately included in the study so that their development could be followed. Stands 21 and 24, near the eastern and western fire boundaries, did not have any seeded grass present in 1978 and stand 18, well within the burned area, had only a trace amount of seeded grass in 1978.

It seems likely that initially the seeded grasses would compete most strongly with other herbaceous vegetation and seedlings of all species. Data from the four stands originally without seeded grasses in figure 6 contrast with the data from the stands where seeded grasses established well. Seeding did produce high herbaceous cover in 1978 and 1979 (fig. 7). Herbaceous cover has declined somewhat from 1979 to 1982 while cover of seeded grasses has declined more rapidly. In 1979 seeded grasses comprised 71 percent of the herbaceous plant layer; in 1982 they had declined to 45 percent of the herbaceous plant cover in those stands with seeded grasses initially. The stands without seeded grasses initially had lower herbaceous cover values in 1978 and 1979 but they had somewhat higher cover values than stands with seeded grasses in the summer of 1982 (fig. 8).

Tree regeneration data from vegetation plots in upland stands is summarized in table 6. In 1982, seedlings outside the plots were observed in all stands listed in table 6 except stands 15 and 16. A few larch trees survived the fire in the area of stand 21 and there are some larch seedlings in the area as well as lodgepole pine. Stands 20 thru 27 have lodgepole pine seedlings in the stand.



Figure 7.—The highest cover values for seeded grasses on upland sites in 1978 were found in areas similar to stand 15. The dominant grass is orchardgrass; however, the grass in bloom is native pinegrass.

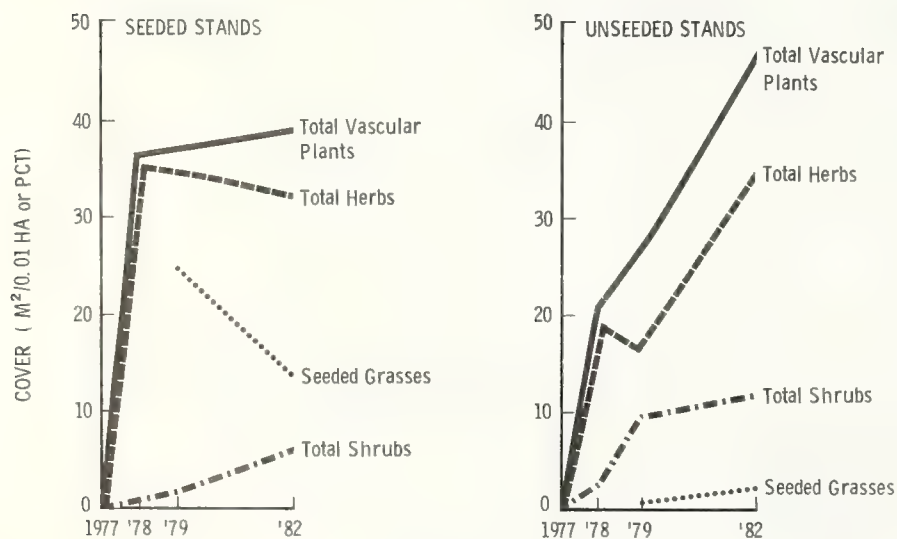


Figure 6.—Cover changes (percentage) for upland stands with seeded grasses initially and those without seeded grasses initially. Solid line indicates total vascular plant cover. Dashed line indicates total herb cover (may include low shrubs under 5 dm with less than one-sixth plot cover). Dashes with dots indicates total shrub cover and dots indicate seeded grass cover.



A



B

Figure 8.—Stand 24 on the west edge of the fire is an example of an area that did not have seeded grass initially. (a) Stand 24 in July 1978; (b) stand 24 in August 1982.

Table 6.—Conifer regeneration as counted in herbaceous vegetation plots within Pattee Canyon stands. Plot area is 6 yd² (5 m²) per stand. Species unknown except as indicated (PSME = *Pseudotsuga menziesii*; PICO = *Pinus contorta* and LAOC = *Larix occidentalis*)

Stand	Vegetation plots			
	1978 spring	1978 summer	1979 summer	1982 summer
-----Number of seedlings-----				
15	—	—	—	1 PSME
16	1	—	—	—
20	2	1	—	3 PICO
21	13	7	2	3 PICO
23	2	—	—	2 PSME
24	2	1	1 PSME	10 LAOC 1 PSME
25	2	—	—	1 PSME 1 PICO
26	5	—	—	4 PSME
27	1	—	—	—

VEGETATIVE RECOVERY ON RAVINE SITES

Field methods and data analysis on ravine sites. Thirteen burned ravine stands were selected for study in addition to the unburned ravine stand cited earlier. All stands were sampled in August and September of 1978 and 1979, and eight of the stands were resampled in 1980. During August and September of 1982, all burned ravine stands were resampled except for stands 10 and 14 which have been dropped from the study due to postfire disturbance.

The ravine study used the permanent nested plot design as described by Stickney (1980). Grass nomenclature follows Hitchcock and Chase (1950) other vascular plant nomenclature follows Hitchcock and Cronquist (1973). Data analysis was the same as described for the upland study. Ravine stands are numbered 1 to 14. The physical features of these stands are listed in table 4 and their locations are shown in figure 4. Appendix A-2 lists cover values for ravine species in individual ravine stands each year the stand was sampled.

Study results on ravine sites. Ravines are compositionally far more heterogeneous than any of the upland areas. Variation and shifts in vegetation are abrupt and frequent, whereas on the open slopes shifts appear to be more gradual. The most conspicuous source of this variation is the moisture gradient from the streambed itself to the adjacent side slopes of the ravine. A generalization of this gradient in a moist ravine is depicted in figure 9. Some of the more common plants associated with this gradient are listed in table 7. This moisture gradient continues on up the side slopes to the ridgetop.

Plot placement was subjective and generally attempted to parallel the axis of the ravine in either zone 2 or

zone 3. In narrow ravine areas stream curvature may introduce some elements of zone 1; examples are found in stands 5 and 14.

In higher dry ravines without summer overland flow this gradient disappears. Plots in stands 8, 9, and 10 were placed in different areas of the same upper dry ravine in order to represent some of the variation present in those ravines.

Table 8 contains cover and volume means for the seral community life-forms and some important species within the ravine sites sampled in 1978, 1979, and 1982. Recovery was generally more rapid than on upland sites and, with the exception of the seeded grasses, most species present in the initial stages of recovery resprouted from root crowns or rhizomes. Growth of these resprouts, both shrub and herbaceous, was rapid and by the summer of 1978 the ravines as a whole had 77.4 percent vascular plant cover with 90 percent of that cover resulting from native species.

By 1982 shrub cover in the burned ravine stands was 77 percent of that in unburned ravine stand 7. Serviceberry and Rocky Mountain maple in the unburned stand were very tall so that shrub volume in the burned stands was only 40 percent of the unburned stand.

Tree regeneration in the ravines has been minimal. Mature larch and Douglas-fir survived the fire in stands 5, 11, and 12 and in the ravines above stands 6 and 14. An inspection of the slopes near stand 5 in 1980 revealed larch seedlings, but no seedlings have been observed in the ravine plots except for stand 6, which had three Douglas-fir seedlings within the $\frac{1}{2}$ -m² plots.

The distribution of seeded grasses in the ravines appears to be related to burn severity, available moisture and whether or not a given area received seed. In

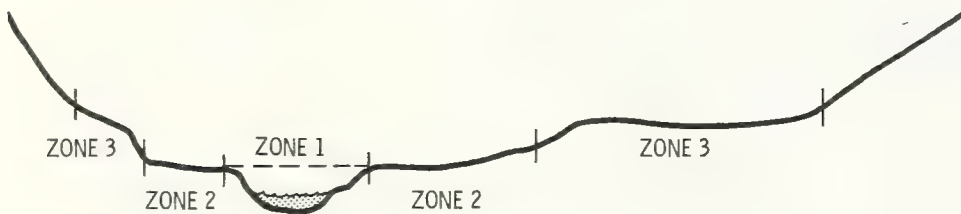


Figure 9.—Gradation across a Pattee Canyon ravine. Some representative species from each zone are listed in table 7.

Table 7.—Species most frequently found in ravine zones identified in figure 9

Zone 1	Zone 2	Zone 3
<i>Mimulus guttatus</i>	<i>Acer glabrum</i>	<i>Physocarpus malvaceus</i>
<i>Veronica americana</i>	<i>Mitella stauropetala</i>	<i>Acer glabrum</i>
<i>Veronica serpyllifolia</i>	<i>Osmorhiza chilensis</i>	<i>Calamagrostis rubescens</i>
<i>Cardamine pensylvanica</i>	<i>Galium triflorum</i>	<i>Aster conspicuus</i>
<i>Urtica dioica</i>	<i>Urtica dioica</i>	<i>Arnica cordifolia</i>
<i>Cinna latifolia</i>	<i>Cinna latifolia</i>	<i>Smilacina stellata</i>
<i>Glyceria grandis</i>	<i>Glyceria grandis</i>	<i>Anaphalis margaritacea</i>
<i>Athyrium filix-femina</i>	<i>Symphoricarpos albus</i>	<i>Symphoricarpos albus</i>
	<i>Spiraea betulifolia</i>	<i>Spiraea betulifolia</i>
	<i>Rubus parviflorus</i>	<i>Rubus parviflorus</i>

Table 8.—Ravine cover and volume means for ravine stands. Stands 7, 10, and 14 were not visited in all years and are not included in the means

	Cover			Volume		
	1978	1979	1982	1978	1979	1982
	Percent or m ² /0.01 ha			-----m ³ /0.01 ha-----		
Shrubs:						
<i>Acer glabrum</i>	2.0	5.6	8.9	4.0	10.5	24.2
<i>Amelanchier alnifolia</i>	1.2	2.1	3.5	1.5	4.2	7.0
<i>Physocarpus malvaceus</i>	3.6	6.2	11.5	2.0	5.0	36.9
<i>Rubus parviflora</i>	10.2	13.8	15.5	4.8	8.5	10.1
<i>Spiraea betulifolia</i>	4.8	4.8	3.3	1.6	1.9	1.4
<i>Symphoricarpos albus</i>	5.9	6.7	17.1	3.3	4.1	36.4
<i>Vaccinium globulare</i>	—	.5	.4	—	.1	.1
Total shrubs	29.3	43.2	64.1	18.8	38.4	105.3
Herbs:						
Seeded grasses						
<i>Agropyron trichophorum</i>	.1	.6	1.8	.1	.7	1.1
<i>Bromus inermis</i>	.1	.5	.8	T ¹	.3	.5
<i>Dactylis glomerata</i>	6.0	13.7	10.9	2.4	9.9	3.2
<i>Festuca arundinacea</i>	.1	.7	T	—	—	—
Total seeded grass	7.5	18.1	13.6	2.5	10.9	4.8
Other Herbs						
<i>Aster conspicuus</i>	1.4	2.1	2.0	.6	.9	.6
<i>Calamagrostis rubescens</i>	1.0	2.3	1.3	.4	1.1	.2
<i>Galium triflorum</i>	1.6	2.4	.5	.3	.5	.1
<i>Mitella stauropetala</i>	.4	1.8	1.2	T	.1	.1
<i>Osmorhiza chilensis</i>	1.0	1.3	T	.3	.4	T
Total herbs ²	48.1	51.8	42.8	13.9	23.7	11.9
Total vascular plants	77.4	95.0	106.9	32.7	62.1	117.2

¹ = trace.

²May include shrubs under 5 dm tall with less than one-sixth cover in individual plots.

ravines the relationship between burn severity and moisture was of particular importance. In the moist, lower ravines where the fire was severe enough to completely expose mineral soil, the seeded grasses exhibit high cover and volume (fig. 10). In microsites where the ravine was wettest, the fire effects were minimal. In these latter areas natural revegetation by the ground layer plants and the presence of unburned duff prevented establishment of seeded grasses on the ravine floor. In steeper, drier ravines the seeded grass either established well, but did not attain the height or cover in comparison to the moist areas, or was absent altogether.

Table 9 compares stands originally without seeded grasses with the steeper, well-drained sites having seeded grasses and with the moist lower ravines having seeded grasses.

Observations in the moist lower ravines indicate that there were some reductions in low shrubs and native herbaceous species during 1978 and 1979; competition with seeded grasses may have been a factor. Herbaceous species also declined in 1982, which appears to be related to shrub shading in all the ravine stands.

FUEL LOADING ON STUDY AREA

Fuel inventory and analysis. Studies of the fuels during the first 3 years following the fire were done as a second feature of the two primary studies of vegetative recovery. Fuel loading measurements were carried out according to the method recently described by Brown,



Figure 10.—Seeded grass sprouting in June 1978 within one of the severely burned, moist, lower ravines where the seeded grasses did best.

Table 9.—Cover values for seeded grass and the total herb layer (may include some shrubs under 5 dm)

Sites	Year	Seeded grasses	Total herbs	Total vascular plants	Seeded grass/total herbs
		Percent or m ² /0.01 ha			Percent
Ravine stands without seeded grass or with only trace amounts initially	1978	0.2	48.3	85.2	—
	1979	.7	48.4	107.6	1
	1982	1.7	37.8	125.2	4
Well-drained ravine stands with seeded grasses	1978	12.5	44.1	63.4	28
	1979	15.8	42.5	67.5	37
	1982	10.4	34.6	70.3	30
Moist ravines with seeded grasses	1978	14.2	49.5	73.4	29
	1979	41.2	60.8	93.1	68
	1982	30.4	53.1	102.3	57

Table 10.—Average fuel loadings for ravines, uplands, and unburned stands in Pattee Canyon, 1978-80

Fuels	Ravine stands			Unburned ravine stands	Upland stands			All stands		
	1978	1979	1980	1978	1978	1979	1980	1978	1979	1980
Number of plots	54	53	31	4	55	54	33	109	107	64
	Pounds/ft ² (kg/m ²)									
Dead fuels										
0-1 inch	0.04	0.04	0.04	0.03	0	0.01	0.01	0.02	0.02	0.03
1-3 inches	.09	.07	.08	.09	.03	.02	.04	.06	.04	.06
over 3 inches, sound	.33	.35	.37	.40	.20	.32	.39	.27	.34	.38
over 3 inches, rotten	.07	.06	.06	.04	.04	.01	.03	.06	.04	.04
grass and forbs		.01	.01			.01	.01		.01	.01
shrub	.01							.01		
litter	.01	.02	.02	.05	.03	.01	.01	.02	.02	.02
duff	.57	.56	.49	1.86	.23	.03	.12	.40	.30	.30
Total dead fuels	1.12 (5.60)	1.11 (5.55)	1.07 (5.35)	2.47 (12.35)	.53 (2.65)	.42 (2.10)	.62 (3.10)	.83 (4.15)	.77 (3.85)	.84 (4.20)
Live fuels										
Grass and forbs	.02	.03	.03		.03	.02	.02	.03	.03	.03
Shrubs	.03	.02	.05	.03		.01	.01	.02	.02	.03
Total live fuels	.05 (.25)	.05 (.30)	.08 (.40)	.03 (.15)	.03 (.15)	.03 (.15)	.03 (.15)	.05 (.25)	.05 (.25)	.06 (.30)
Total all fuels	1.17 (5.85)	1.17 (5.85)	1.16 (5.80)	2.50 (12.50)	.56 (2.80)	.45 (2.25)	.65 (3.25)	.88 (4.40)	.82 (4.10)	.90 (4.50)

Oberheu, and Johnston (1982). Fuel plots were located randomly within the stands used for upland and ravine vegetative analysis, rather than randomly across the entire burn. Fuel data were taken for all upland and ravine stands in 1978 and 1979 and for stands 2, 3, 4, 5, 9, 13, 14, 15, 16, 17, 18, 21, 24, and 26 in 1980. Fuel loading sample plot data were analyzed by the USDA Forest Service FUELS computer program (Brown, Oberheu, and Johnston 1982).

Results of fuel study. Fuel loading results for both the ravine and upland sites are presented in table 10. The results show little change in fuels during the first 3

postfire years. Where possible the same plots were used all 3 years; however, it was not always feasible to relocate the exact plots. Some variation in loads between years can be attributed to the differences between plots. There does appear to be a slight but definite increase in the greater-than-3-inch-sound category, probably caused by falling fire-killed trees. The decrease in ravine duff in 1980 was caused by the omission of a wet, lightly burned ravine area with high duff levels. The drop in upland duff in 1979 can not be explained. The seeded grasses have contributed to a rapid increase in the grass and forb category and, following the first year, in the dead grass and forb category.

Generally the fuel loads in ravines are heavier than those on upland sites. For some categories, such as duff, the higher ravine loads can be attributed to the inclusion of relatively unburned areas in the ravine sample. For the live fuels, however, the difference is caused by the more mesic conditions in the ravines.

There were only four fuel plots in the unburned ravine area of stand 7, but they indicate some potential differences in fuels in the grass and forb, duff and litter layers. Under the dense canopy the understory vegetation is sparse. The amount of duff is relatively low in this rather dry ravine and probably comparable to amounts found generally before the fire.

Tree seedling data is also collected in this method. In 1979 seedlings were only found in stand 24, with about 100 Douglas-fir per acre and 100 lodgepole pine per acre. In 1980 lodgepole pine seedlings were found in stand 21 with approximately 1,275 per acre; stand 24 with 200 per acre, and stand 26 with 360 per acre. Larch seedlings were also found in stand 24 in 1980 with 100 per acre. Seedling distribution is very uneven in these plots.

MOSS DEVELOPMENT ON STUDY AREA

Field methods and data analysis. Daubenmire (1970) implies that mosses and lichens are important in preventing wind erosion in Washington steppe and it has also been shown that certain mosses and liverworts are characteristic of newly burned areas (Duncan and Dalton 1982). In Pattee Canyon, bryophytes and lichens were sampled in the same transects used for the permanent vegetation samples (McCune 1978). Both upland and ravine stands were sampled in 1978 and most upland stands were resampled in 1979. Transects were composed of two 25-m segments, with 2- by 5-dm quadrats spaced at 2-m intervals; thus, 25 quadrats were analyzed per plot. Modified Daubenmire (1959) percentages of cover classes were used to evaluate species cover within the quadrats: 0-1 percent, 1-5 percent, 5-15 percent, 15-25 percent, 25-50 percent, 50-75 percent, 75-95 percent, and 95-100 percent. Cover class midpoints were averaged to arrive at a single percentage of cover value for each species for each stand. Nomenclature of mosses follows Crum and others (1973).

Results of moss study. Soon after snowmelt the spring following the fire, mosses and liverworts were apparent on the burn and they continued to spread during the early summer. This bryoid layer was well developed by the September 1978 sample, aided by a cool, moist spring and early summer. On upland sites the principal colonizing species were *Ceratodon purpureus*, *Bryum* spp. (mainly *Bryum caespitium*), *Funaria hygrometrica*, and *Marchantia polymorpha*. The first two had an average combined cover of 22 percent. They are pioneer species that colonize disturbed soil throughout the Northern Hemisphere. Bryophyte data are summarized in table 11 and found in appendix B.

The fire destroyed mosses and epiphytic lichens throughout the burned area except for a few small areas near the burn perimeter and in some ravines. The same colonizing mosses that were found on upland sites were also found in the ravines, although their cover was generally less in ravines.

Table 11.—Bryophyte cover, 1978-81

Species	Ravines	Uplands		
	1978	1978	1979	1981
	Percent			
<i>Brachythecium</i> spp.	9.6	0.1	0.1	—
<i>Bryum</i> spp.	2.1	7.0	7.2	33.0
<i>Ceratodon purpureus</i>	3.7	15.4	14.6	17.2
<i>Funaria hygrometrica</i>	.1	.6	.3	.1
<i>Leptobryum pyriforme</i>	1.3	.3	—	—
<i>Marchantia polymorpha</i>	.7	.4	0	.4
<i>Plagiomnium insigne</i>	5.0	—	—	—
<i>Polytrichum juniperinum</i>	T ¹	.1	T	1.5
<i>Rhytidadelphus triquetrus</i>	1.1	—	—	—
<i>Timmia austriaca</i>	.9	—	—	—

¹T = trace (less than 0.5 percent).

In 1979, mosses on the upland sites remained generally the same. *Marchantia polymorpha* disappeared, apparently because of the dry summer. Moist ravine sites, which were not revisited by McCune in 1979, did still contain some *Marchantia* in 1979.

In 1981 mosses increased, with *Bryum caespitium* perhaps increasing at the expense of *Ceratodon purpureus* (table 11). *Polytrichum* also appears to be gaining cover and will probably continue to increase in the future. *Marchantia* reappeared on upland sites and lichens (*Peltigera* sp.) appeared on upland sites for the first time since the fire.

DISTRIBUTION OF CONIFER REGENERATION IN THE STUDY AREA

Sampling methods. In order to determine the relative success of conifer regeneration, seedling data were gathered during the summer of 1980. Transects were established along elevational contours. Four transects were placed completely across the burn at 400-foot (122-m) intervals (at 5,400, 5,000, 4,600, and 4,200 feet elevation; 1 646, 1 524, 1 402, and 1 280 m). A few plots at the western edge of the 4,200-ft (1 280-m) transect are within the area that was salvage logged in 1978. Some partial transects were also run at 4,300 and 4,400 feet (1 311 and 1 341 m) elevation in order to gather more data in the area left unseeded by introduced grasses. Circular, 1/300-acre (13.5-m²) plots were spaced at 328-foot (100-m) intervals along each transect. There were 126 of these seedling plots.

Within each plot, the total number of seedlings of each tree species was recorded. In addition the height and age of the three tallest individuals were recorded. Site variables recorded at each plot included elevation, slope, aspect, duff depth, and indications of soil movement. The presence or absence of standing live or dead trees, and the distance and species of the two nearest potential seed trees (considered if within 150 feet; 46 m) were listed. Presence or absence of understory vascular plants and bryophytes in each plot was recorded.

Results of seedling inventory. The major tree species present before the fire were Douglas-fir, western larch, ponderosa pine, and, above 4,500 feet (1 372 m),

lodgepole pine. Subalpine fir (*Abies lasiocarpa*) is confined to the upper ravines on this site. A few apparently serotinous lodgepole pine stands were located in the upper reaches of the burn.

Tree seedlings on the Pattee Canyon burn occurred with such low frequency that a statistical analysis of the findings would not provide sufficient evidence to warrant projections of tree recolonization. Only 17 of 126 plots actually contained conifer seedlings. Tree seedling data from these plots are in table 12 and maps of the seedling locations are in appendix C. Although good quantitative information is lacking, certain qualitative features of seedling distribution were noted.

Many of the seedlings found were located near the edge of the burn or near islands of live trees within the burn. Some sites were without seedlings despite the

close proximity of seed trees. But with few exceptions, plots with seedlings were reasonably close to seed trees. Where dead lodgepole pines with fire-opened cones were found, lodgepole pine seedlings were dense.

Data for understory species with greater than 10 percent total frequency are summarized by elevation (table 13). Spirea and snowberry appear to decrease slightly in frequency with increasing elevation. Ceanothus (*Ceanothus velutinus*) is not common on the burned area but did have 8 percent and 10 percent frequency at 5,000 and 5,400 feet (1 524 and 1 646 m) elevation, respectively. Fireweed shows a decided increase in frequency in the area left unseeded and pinegrass shows a lesser increase in the same area. In addition, the number and percent of plots with evidence of overland flow is listed for each elevation (table 13).

Table 12.—Tree seedling data for Pattee Canyon fire area, 1980

Species	Elevation where present	Number of plots of occurrence	Total number of seedlings	Total number of plots	Number of seedlings/acre
	Feet (meters)				
<i>Pinus</i>	5,000 (1 524)	5	40	25	1,236
<i>contorta</i>	4,600 (1 402)	2	5	39	38.5
<i>Larix</i>	5,000 (1 524)	1	5	25	60
<i>occidentalis</i>	4,400 (1 341)	1	3	7	128.4
	4,200 (1 280)	2	3	45	20.0
<i>Pseudotsuga</i>	4,600 (1 402)	3	5	39	38.5
<i>menziesii</i>	4,400 (1 341)	1	1	7	42.9

Table 13.—Percentage frequency in tree seedling plots for understory species with greater than 10 percent total frequency and number and percentage of plots with accelerated overland flow. Plots at 4,300 feet and 4,400 feet were in the area that was not seeded

Species and flow types	n =	Elevation in feet (meters)					Total
		4,200 (1 280)	4,300- 4,400 (1 311- 1 134)	4,600 (1 402)	5,000 (1 524)	5,400 (1 646)	
		45	7	39	25	10	126
----- Percent -----							
UNDERSTORY SPECIES							
Shrubs:							
<i>Acer glabrum</i>		15	14	7	12	—	11
<i>Amelanchier alnifolia</i>		11	14	26	20	20	18
<i>Physocarpus malvaceus</i>		51	29	72	44	30	53
<i>Spiraea betulifolia</i>		62	43	46	32	20	47
<i>Symphoricarpos albus</i>		36	57	26	8	—	25
<i>Vaccinium globulare</i>		7	—	5	28	10	11
Grasses:							
<i>Agropyron trichophorum</i>		42	—	—	—	—	15
<i>Bromus inermis</i>		9	14	33	36	20	23
<i>Calamagrostis rubescens</i>		60	86	51	32	—	48
<i>Dactylis glomerata</i>		78	—	49	76	40	61
Forbs:							
<i>Aster conspicuus</i>		29	29	28	16	—	24
<i>Epilobium angustifolium</i>		16	86	38	20	—	26
OVERLAND FLOW							
Number of plots with evident overland flow		4	—	9	8	2	23
Percentage of plots with overland flow		8	—	23	32	20	18

DISCUSSION OF INITIAL VEGETATIVE RECOVERY FOLLOWING PATTEE CANYON FIRE

General Discussion

Early succession vegetation on the Pattee Canyon burn derived from two primary sources: first, the vegetative regrowth of shrubs and perennials, and second, the establishment of artificially seeded grasses. Establishment of annual and perennial herbs or shrubs from natural off-site seed sources was a relatively minor component in the first postfire year (1978). Secondary colonization from some perennials surviving the fire and setting seed became more important in later years.

Although vegetative recovery from the fire was not quantitatively measured until late June and July 1978, casual observations made in late summer and fall of 1977 revealed shrub resprouts along roads and in ravines. Resprouts noted in 1977 included serviceberry, Rocky Mountain maple, ninebark, rose (*Rosa* sp.), and Scouler willow (*Salix scouleriana*) (fig. 11).



Figure 11.—Willow (*Salix scouleriana*) resprouting following the fire.

In April 1978, white spirea and common snowberry (*Symphoricarpos albus*) were resprouting on severely burned sites, along with spring geophytes, conspicuous aster (*Aster conspicuus*), heartleaf arnica, and pinegrass. Less severely burned areas on the eastern edge of the fire exhibited a wider variety of resprouts, including fire-sensitive plants, for example, kinnikinnick (*Arctostaphylos uva-ursi*). Only a few annuals were seen. Slenderleaf collomia (*Collomia linearis*) and blue-eyed Mary (*Collinsia parviflora*) were present and miner's lettuce (*Montia perfoliata*) was conspicuous in many areas. Rapidly sprouting artificially seeded grass was also very conspicuous in most areas. During the spring of 1978, however, much of the burned area was black ash, and

resprouts of perennials were scattered. Vegetative cover in ravines was somewhat more dense, but still scattered.

By late June 1978, quantitative sampling began. Artificially seeded grasses were well established and had achieved canopy coverage values of up to 32 to 36 percent in some upland plots. Native pinegrass responded quickly on upland sites and in drier ravine sites. In the ravines, shrub regrowth from rootstocks and rhizomes was already vigorous, with up to 40 percent cover.

Annuals were most common on the burned area the first spring although they were a minor part of the vegetation. In addition to the annuals cited earlier, prickly lettuce (*Lactuca serriola*) established successfully on the burn in 1978. Its height made it conspicuous by summer and, although it achieved greater than 1 percent cover in only one stand, it was present in nine of the ravine stands and 10 of the upland stands.

By August and September 1978, the spring geophytes, early flowering perennials, especially heartleaf arnica, and spring annuals had either disappeared from view or were represented by greatly reduced cover. Summer flowering perennials, including the seeded grasses, and shrubs were close to maximum development for the year.

In 1979, few annuals were present in either upland or ravine plots. May, June, and July of 1979 had less than 50 percent normal precipitation and herbaceous flora on upland sites and in dry ravines decreased slightly in cover. This did not appear to affect the moist ravines.

Lyon and Stickney (1976) describe the characteristic pattern for forest succession in the Northern Rocky Mountains as an initiating herb stage followed in turn by shrub and tree stages. This model of succession uses the dominant life-form rather than vegetation composition as the basis for successional stages and compares the shrub and tree layers with the herbaceous layer. The life-form patterns for the first 2 to 3 years of upland and ravine postfire development in Pattee Canyon are summarized in figures 12 and 13.

By the fifth postfire year (1982) the ravines generally were shrub dominated, although four sites (stands 1, 3, 4, and 8) had only 40 to 47 percent shrub cover. The seven other ravine sites visited in 1982 had 56 to 78 percent shrub cover. While most upland areas are still herb dominated, stand 19 has 51 percent shrub cover.

Recovery of Conifers

In addition to the 1980 study of the distribution of conifer regeneration, tree regeneration data were gathered during the upland study, the ravine study, and while determining fuel loads for the stands in these studies. All these sources of tree regeneration data indicate few seedlings are present and those are clumped near the burn edges, near surviving trees or near serotinous lodgepole pines. The lodgepole pine seedlings that established following the fire have gained sufficient height to be readily visible above herbaceous vegetation by 1982 and are scattered across the burn. Most of the lodgepole pine seedlings observed were above 4,800 feet (1 460 m) elevation but occasional individuals were observed down to about 4,100 feet (1 250 m).

Lodgepole pine regeneration following fire is dependent on a "one show" effort. In the next few years a

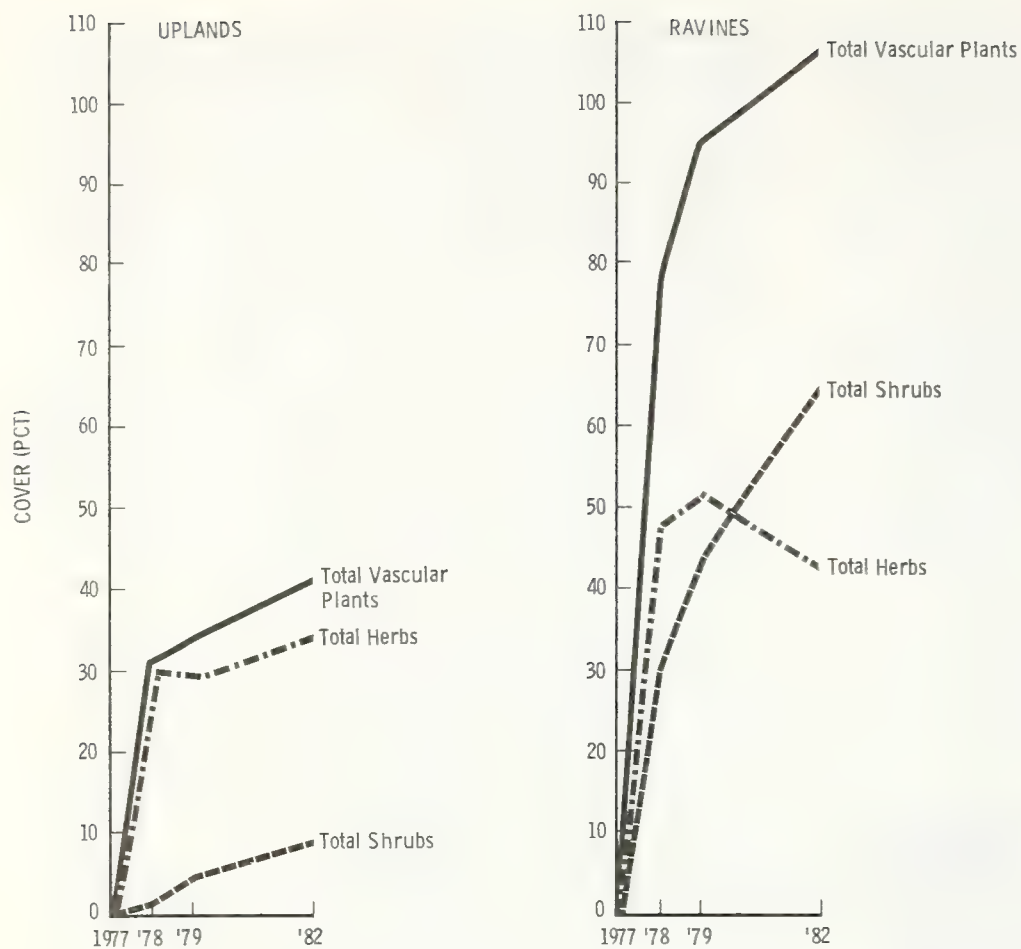


Figure 12.—Upland and ravine cover means for life-forms. Solid lines indicate total vegetative cover; dashed lines indicate shrub cover; and dots and dashes indicate herbaceous cover.

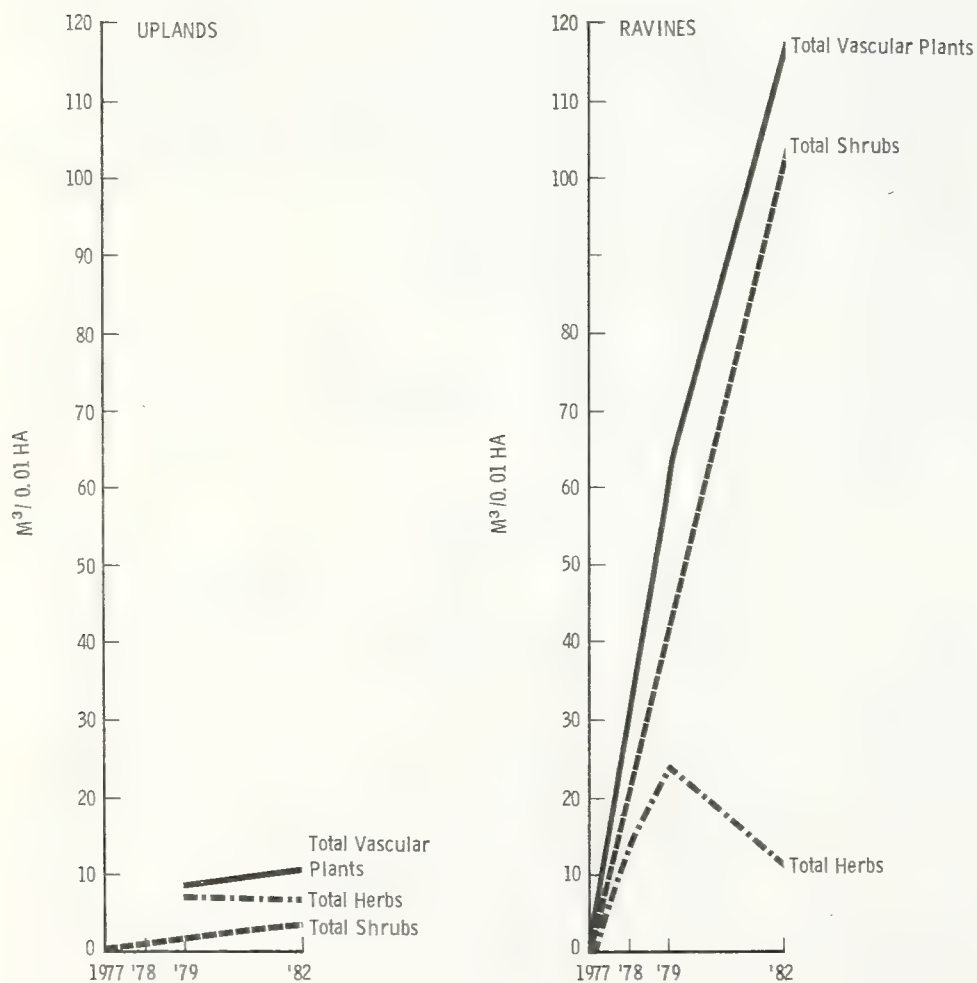


Figure 13.—Upland and ravine volume means for life-forms. Solid lines indicate all vascular vegetation; dashed lines indicate shrubs; and dashes with dots indicate herbaceous vegetation.

moderate disturbance, such as a light ground fire, could eliminate the present seedling crop. This would diminish dramatically the relative success of lodgepole pine on the burn. With a more constant seed source in the face of moderate disturbance, other conifers could fare better in the long run. Without any disturbance, lodgepole pine's early maturity may allow it to increase in proportion to other species in the developing postfire stand.

Recovery of Individual Understory Species

This discussion of understory species attributes is based on observation and data collected on the Pattee Canyon site only. Species may behave differently on different habitats within the limits of their range.

SHRUB RESPONSE

Of all the shrubs considered, only ninebark, white spirea, and huckleberry have at least 1 percent mean cover on both upland and ravine sites. Thimbleberry, Rocky Mountain maple, common snowberry, and serviceberry are important in the ravines while huckleberry has little cover at present. Serviceberry has shown the most damage from browsing by deer in the first years since the fire. Postfire response of shrubs in Pattee Canyon is shown in table 14. Increases in volume for the most dominant ravine shrubs are shown in figure 14.

Competitive ability in shrubs is frequently related to their ability to spread from rhizomes. Those species that spread from rhizomes tend to show clustered (aggregated) distributions. On the Pattee Canyon burn, patches of blue huckleberry, thimbleberry, and common snowberry are conspicuous. Thimbleberry made a rapid recovery in the first years and then gained volume more slowly up to the fifth year; snowberry recovered more slowly initially and has increased its volume very rapidly in the third to fifth year interval. Spirea is more uniformly distributed; it resprouted quickly, maintained nearly the same cover during 1979 and 1980, but subsequently has declined in most areas.

Resprouts of blue huckleberry were few in 1978, increased somewhat in 1979, and then increased more by 1982 on upland sites. Miller (1977) states that the depth of heat penetration controls the number of *Vaccinium globulare* resprouts. Density increases if stems are killed just below ground level, so that sprouts appear from rhizomes; however, density decreases if heat kills the shallow rhizomes and sprouting occurs from deeper levels with fewer rhizomes. The Pattee Canyon fire was severe in many areas and blue huckleberry's recovery was slow. All plants sampled in ravine patches of resprouting blue huckleberry during 1980 were sprouting from lateral rhizomes located at depths of 3.5 to 6 inches (9 to 15 cm).

Table 14.—Postfire behavior of some Pattee Canyon shrubs

Species	Fire survival	Seed production	Expansion potential
<i>Physocarpus malvaceus</i>	Root crowns	Occasional plants flowered in 1980 most plants flowered in 1981	Appears to be slow
<i>Acer glabrum</i>	Root crowns	Did not set seed in the 1st 3 post-fire years. Did have seeds by the fifth summer	Has winged samara
<i>Spiraea betulifolia</i>	Rhizome	Set seed the first year following the fire	Can spread vegetatively by rhizomes and has early seed production
<i>Symphoricarpos albus</i>	Rhizome	Some fruit the first postfire year	Vegetative spread by rhizomes; bird carried seed
<i>Vaccinium globulare</i>	Both shallow and deep rhizomes	Fruit the third postfire year	Vegetative spread by rhizomes; bird carried seed
<i>Amelanchier alnifolia</i>	Root crowns	Fruit the second postfire year	Animal carried seed
<i>Rubus parviflorus</i>	Rhizomes	Fruit the first postfire year	Spreads vigorously by rhizomes; bird carried seed

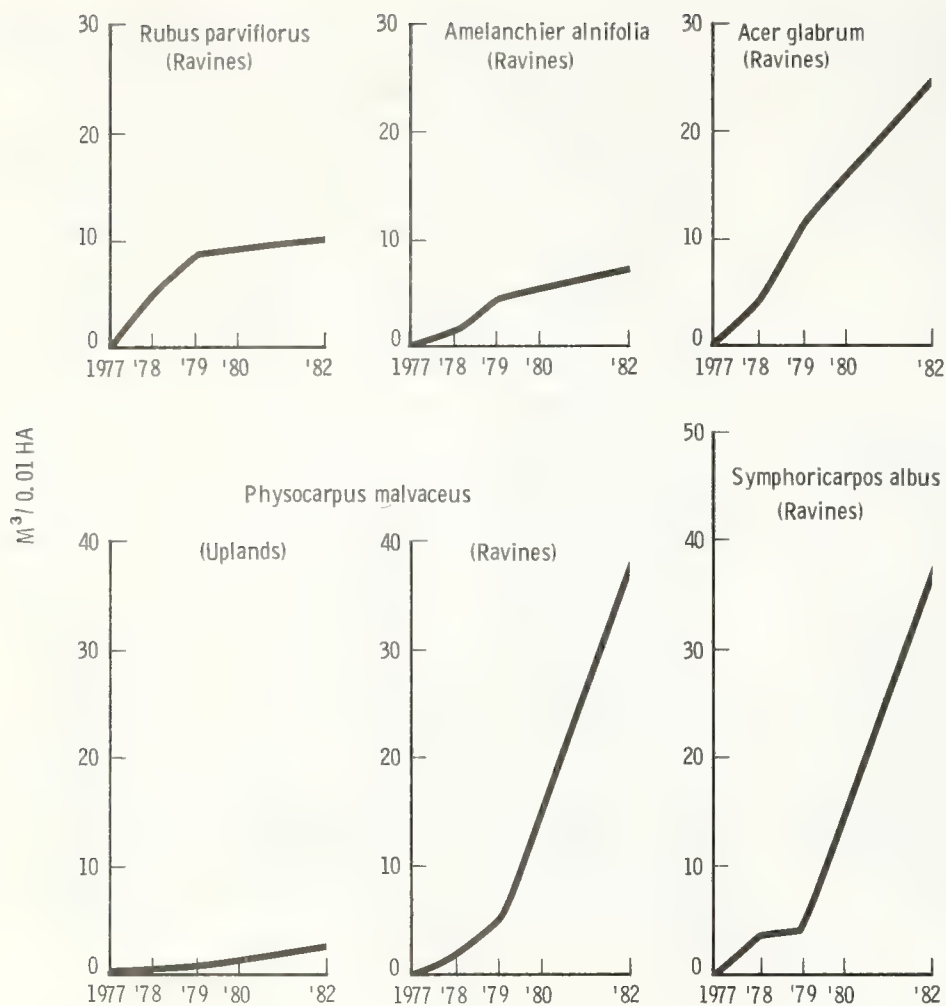


Figure 14.—Volume changes for dominant shrub species since the fire. Solid lines indicate volume in all ravine stands. Volume = $1 dm^3/0.01 ha$.

HERBACEOUS SPECIES RESPONSE

The most abundant native species on the burn is pinegrass. Pinegrass maintains itself in dense forest shade but only produces seed in forest openings. Spring and summer regrowth and spread in 1978 were from rhizomes. It also bloomed profusely during the summer of 1978 (fig. 15) and seedlings were observed during the 1979–1981 seasons. Cover increases in 1982 may reflect this new growth. Postfire behavior of pinegrass and some other herbs is found in table 15.

Common fireweed (*Epilobium angustifolium*) is widely distributed on the burn with low mean cover values of less than one percent. It resprouted from roots (sometimes considered as rhizomes) during spring of 1978 in many ravines and possibly on upland sites. Blooming the first season was profuse on the scattered surviving plants, producing light, wind-blown seeds.

Both heartleaf arnica and broadleaf arnica (*A. latifolia*) are present on the burn. Heartleaf arnica is more generally distributed, while broadleaf arnica is restricted to ravine side slopes. Conspicuous aster is also rhizomatous, with wind-blown seeds. The arnicas form clumps similar to those produced by rhizomatous shrubs and have dispersed little otherwise; the aster is more generally distributed and forms only small clumps.

Two other widely distributed ground layer species are creeping Oregon-grape (*Berberis repens*), a low subshrub considered in this study with the herbaceous layer, and western meadowrue. They are stoloniferous or



Figure 15.—Pinegrass in bloom during summer 1978.

Table 15.—Postfire behavior of some Pattee Canyon herbs and mosses

Species	Fire survival	Seed production	Expansion potential
Perennials:			
<i>Arnica cordifolia</i>	Rhizomes	Seed set the first year	Some vegetative spread from rhizomes; wind-carried seeds
<i>Arnica latifolia</i>			
<i>Aster conspicuus</i>			
<i>Berberis repens</i>	Stolons	Few flowers the first postfire year more the second	Bird carried fruit
<i>Calamagrostis rubescens</i>	Rhizomes	Bloomed profusely the first postfire summer; continued blooming succeeding years	Good recovery from both rhizomes and seed
<i>Epilobium angustifolium</i>	Rhizome-like roots and wind-carried seed	Began blooming profusely the first postfire summer	Some vegetative spread from rhizomes; wind-carried seed
<i>Galium triflorum</i>	Shallow, fine rhizomes; survived in moist areas	Bloomed the first postfire year	Small, barbed seeds carried by animals; limited expansion
<i>Geum macrophyllum</i>	Short root stocks	Bloomed the first postfire year	Spread limited to moist ravines
<i>Linnaea borealis</i>	Creeping stems; only in sheltered microsites	Not observed	Vegetative spread by creeping stems
<i>Mimulus guttatus</i>	Short stolons along side streams	Bloomed the first postfire year	Expanding into newly shade-free stream-side sites
<i>Osmorhiza chilensis</i>	Short, shallow roots	Bloomed the first postfire year	Barbed seeds carried by animals
<i>Pyrola secunda</i>	Slender rhizomes in sheltered microsites	Not observed	Possible seedling; source unknown
<i>Urtica dioica</i>	Strongly rhizomatous; moist sites	Bloomed the first postfire year	Vegetative spread; possibly seedlings
Annuals:			
<i>Corydalis aurea</i>	Possibly soil-stored seed	Bloomed and set seed first postfire year	Almost disappeared the second postfire year
<i>Geranium bicknellii</i>			
<i>Lactuca serriola</i>			
	Off-site wind-blown seed	Set seed first year	Almost disappeared the second postfire year
Mosses:			
<i>Bryum caespitium</i>	Light off-site wind-blown spores	Produced few spores late the first postfire year; many the second	By wind-carried spores; vegetative expansion
<i>Ceratodon purpureus</i>			

rhizomatous and have low cover values, especially on upland sites, following the 1977 fire.

Spring ephemerals with deep corms or rhizomes were usually present in sampling plots as dead stalks or litter by late summer. Lambstongue fawnlily (*Erythronium grandiflorum*) is common across the burn. Casual observations indicate that it sprouted and bloomed in 1978; however, in the spring of 1979 and 1980 lambstongue fawnlily flowers were spectacular across the burn.

Sweetscented bedstraw (*Galium triflorum*) is found primarily in ravines. Shallow, fine rhizomes along with small, barbed seeds allow it to persist and spread in such areas. Mountain sweetroot (*Osmorhiza chilensis*) persists from rootstocks, has barbed seeds, and does best in moist ravines. Both had the highest cover values in 1979, the second summer after the fire, and have declined in cover since.

Largeleaf avens (*Geum macrophyllum*), common monkeyflower (*Mimulus guttatus*), and stinging nettle (*Urtica dioica*) apparently expanded their populations in moist ravines since the fire; however, they are primarily found on the moistest sites and were not quantitatively sampled in plots. Stinging nettle, particularly, appears to thrive on disturbance, although its rate of spread following the fire may have been slowed by competition

from orchardgrass combined with an infestation of caterpillars in 1979 and 1980.

A few species present the first summer after the fire possibly were present as buried seed before the fire. Examples include Pennsylvania bittercress (*Cardamine pennsylvanica*), golden corydalis (*Corydalis aurea*), dragonhead (*Dracocephalum parviflorum*), and Bicknell geranium (*Geranium bicknellii*). Since the first postfire year Pennsylvania bittercress has been observed on exposed sites following spring flooding; golden corydalis has disappeared completely; and both American dragonhead and Bicknell geranium have occasionally been observed in trace amounts. Prickly lettuce (*Lactuca serriola*) was the only annual with wind-carried seed that established in enough quantity to receive a cover value in any plot in 1978.

Rowe (1979) considers creeping subshrubs to be fire avoiders. Sidebells shinleaf (*Pyrola secunda*) and kin-kinnick are in this classification; nevertheless, both were present on the burn by the first summer, mainly as occasional resprouts in sheltered microsites. *Pyrola* seedlings were also found in one of the drier ravine sites during 1979. In contrast, prince pine (*Chimaphila umbellata*) was present in this area, according to Schuler (1968), and has not been observed on the burn since the fire.

MOSS RESPONSE

The dominant species of moss colonizing the burn immediately following the fire resulted from spores (table 15) borne by the wind from off site sources. Such mosses initially spread vegetatively. Spores survived and germinated best in sheltered microsites. The liverwort *Marchantia polymorpha* also colonized the burned area although it was infrequently found in Pattee Canyon prior to the fire (McCune 1978). Propagules may have come from residual *Marchantia* populations in moist ravines for the initial colonizing populations in 1978 and the recolonizing populations in 1980.

Response of Seeded Grasses

The four perennial grasses seeded on the burn are either bunchgrasses or sodforming grasses. Orchardgrass established best and has been the major species of seeded grass present in all burn areas. When these grasses were seeded, it was anticipated that orchardgrass would be the strongest competitor and that it would be naturally lost from the site in 10 years, or at most in 20 to 25 years. Seedlings of orchardgrass were present in 1981, indicating some ability to reproduce on this site. Wheatgrass (*Agropyron trichophorum* and *A. intermedium*) has increased its (low) canopy cover since 1978. It has not been determined if this is the result of seedling production.

COMPETITION BETWEEN SEEDED GRASSES AND NATURAL REVEGETATION

The competitive impact of orchardgrass has been strongest and most obvious in the moist, lower ravines. In these areas the orchardgrass has grown very lush and tall, shading and suppressing low shrubs and other herbs. Conversely some plots were observed where orchardgrass and other seeded grasses were shaded and evidently retarded by the vigorous regrowth of resprouting tall shrubs.

The impact of grass seeding on upland sites is not so easily observed. Data suggest that seeded grasses compete and may suppress other species. The grasses shade other vascular plants and compete for nutrients and moisture by aggressive fibrous roots. There is at present insufficient conifer regeneration to reach any conclusions about the impact of orchardgrass on conifer regeneration. In his discussion of the moss layer, McCune (1978) stated that "the herbaceous layer (orchardgrass and pinegrass) sufficiently moderated the microclimate near the ground to allow more survival of the young mosses during dry periods." By 1981, however, mosses were becoming buried in the grass litter and spore production was high (McCune 1981; personal communication).

EROSION CONTROL

Erosion control was a primary purpose for the grass seeding project in the Pattee Canyon burn. Our studies were not, however, designed to monitor erosion, nor were they designed to evaluate the effect of seeded grasses on erosion. Casual observations by study participants indicate that accelerated erosion was not apparent during the first 2 postfire years.

During late May of 1980, several days of above normal rainfall resulted in the flooding of Pattee Creek. Visual inspection of the burned area following the flooding indicated that some soil movement did occur on the steep upper slopes, especially between clumps of orchardgrass and other vegetation. The lower slopes, however, showed little or no apparent erosion. The unseeded area (fig. 3) showed no apparent evidence of erosion following the 1980 storm. Further comments on the benefits of seeding grasses are found in Crane and Habeck (1982).

WILDFIRE HAZARD

Wildfire hazard in the burned area has changed drastically as a result of the fire and subsequent grass seeding. Removal of the forest canopy and most downed woody surface fuels by the fire has eliminated the probability of moderate-to-severe fires for many years to come. The probability of a fast-spreading, low-intensity surface fire does exist as a result of the grass seeding. A nearly continuous mat of dead grass covers most of the burned area. During late summer, after the current year's crop of grass cures, a fire could sweep the area. The result of such a fire would be to set back tree and shrub revegetation.

Summary

On the Pattee Canyon burn the initial vascular vegetation is derived from two main sources; preburn vegetation and seeded grass. (1) At present the most competitive species appear to be orchardgrass and pinegrass, with orchardgrass presently dominant in most areas. (2) In ravines and those upland sites with prefire shrub cover the shrubs have achieved dominance fairly rapidly. (3) It appears, however, that secondary colonization by shrubs will be necessary on many upland sites in the burned area before a shrub stage as defined by Lyon and Stickney (1976) could occur. (4) The recovery of understory plants has been much more rapid in the ravines than on any upland sites. (5) Tree regeneration is at present scarce on most of the burn. Given the distance from seed trees to much of the burned area, it appears that regeneration of conifers may be very slow.

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APPENDIXES A-1 and A-2

(see fold-out at end of publication)

APPENDIX B-1

Composition and percent cover of bryophyte and lichen component within Pattee Canyon ravine communities, 1978. T = trace cover.

Species	Stand number														
	1	2	3	4	5	6	8	9	10	11	12	13	14	7	
-----Percent or m ² /0.01 ha-----															
Bryophytes															
<i>Atrichum selwynii</i>	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-
<i>Aulacomnium androgynum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-
<i>Brachythecium</i> spp.	-	-	-	-	21.4	16.5	-	-	8.8	28.8	16.6	-	27.2	15.1	-
<i>Bryum</i> spp.	2.3	1.1	3.9	4.5	-	-	5.2	8.1	1.4	.8	T	2.5	-	-	-
<i>Campylium chrysophyllum</i>	-	-	-	-	-	-	-	-	-	-	-	-	.1	-	-
<i>Ceratodon purpureus</i>	1.6	.9	2.1	5.0	-	.5	31.7	3.7	.8	.2	T	4.7	-	-	-
<i>Dicranum scoparium</i>	-	-	-	-	-	.1	-	-	-	-	-	-	T	.1	-
<i>Dicranum tauricum</i>	-	-	-	-	-	.1	-	-	-	-	-	-	T	.3	-
<i>Drepanocladus uncinatus</i>	-	-	-	-	-	-	-	-	-	-	.4	-	.1	.1	-
<i>Eurhynchium purchellum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	.4	-
<i>Funaria hygrometrica</i>	.2	.1	.3	.2	-	-	.5	.3	T	T	-	.2	-	-	-
<i>Leptobryum pyriforme</i>	-	-	-	-	-	-	4.7	2.3	10.8	-	-	.5	-	-	-
<i>Marchantia polymorpha</i>	-	-	.5	1.0	-	-	7.2	.5	T	T	-	-	-	.1	-
<i>Mnium spinulosum</i>	-	-	-	-	-	.4	-	-	-	-	.1	-	.2	.8	-
<i>Plagiomnium insignne</i>	-	-	-	-	55.4	8.2	-	-	-	.6	2.1	-	3.3	T	-
<i>Pleurozium schreberi</i>	-	-	-	-	-	T	-	-	-	-	-	-	-	2.5	-
<i>Pogonatum alpinum</i>	-	-	-	-	-	-	.4	-	-	-	-	-	-	-	-
<i>Pohlia cruda</i>	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-
<i>Pohlia nutans</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T
<i>Polytrichum juniperinum</i>	.1	T	T	T	-	-	-	.1	.1	-	T	.1	-	-	-
<i>Ptilium crista-castrensis</i>	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-
<i>Rhizomnium</i> spp.	-	-	-	-	-	4.4	-	-	-	T	.1	-	4.1	-	-
<i>Rhytidadelphus triquetrus</i>	-	-	-	-	2.6	10.2	-	-	-	-	-	-	.5	1.9	-
<i>Timmia austriaca</i>	-	-	-	-	-	3.3	T	-	T	-	T	T	-	9.3	-
<i>Tortula ruralis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lichens															
<i>Peltigera canina</i>	-	-	-	-	-	.1	-	-	.4	-	1.2	-	-	.4	-
<i>Peltigera leucophlebia</i>	-	-	-	-	-	-	-	-	-	-	.1	-	-	1.3	-
<i>Peltigera malacea</i>	-	-	-	-	-	T	-	-	T	-	-	-	-	-	-
<i>Peltigera spuria</i>	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-
Total number of species	4	4	5	5	3	13	7	6	13	7	11	6	9	15	

APPENDIX B-2

Composition and percent cover of bryophyte and lichen component within Pattee Canyon upland communities.

Species	Stand number and year											
	15			16			17			18		
	78	79	81	78	79	81	78	79	81	78	79	81
Percent or m ² /0.01 ha												
Bryophytes												
Atrichum selwynii	-	-	-	-	-	-	-	-	-	-	-	-
Brachythecium albicans	-	-	-	-	-	-	-	-	-	-	-	-
Bryum caespitium	1.6	-	19.1	11.0	5.2	16.4	7.0	2.3	31.0	5.7	5.8	36.0
Ceratodon purpureus	43.1	-	30.0	7.5	9.6	18.8	30.0	34.3	8.6	3.4	2.7	6.8
Dicranum scoparium	-	-	T	-	-	-	-	-	-	-	-	-
Funaria hygrometrica	1.6	-	-	1.1	T	.5	1.2	2.3	.2	.2	T	1.2
Leptobryum pyriforme	-	-	-	-	-	-	T	-	-	-	-	-
Marchantia polymorpha	.1	-	-	.3	-	-	-	-	-	.2	-	-
Minum spinulosum	-	-	-	-	-	-	-	-	-	-	-	-
Pogonatum alpinum	-	-	-	-	-	-	-	-	-	-	-	-
Polytrichum juniperinum	T	-	.1	.2	-	1.9	-	-	.2	.2	.1	2.0
Tortula ruralis	-	-	-	T	-	T	-	-	-	-	-	-
Eurhynchium pulchellum	-	-	-	-	-	-	-	-	-	-	-	-
Lichens												
Cladonia sp.	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera canina	-	-	-	-	-	T	-	-	-	-	-	-
Peltigera leucophaea	-	-	-	-	-	-	-	-	-	-	-	-
Peltigera spuria	-	-	.1	-	-	T	-	-	-	-	-	.2
Total number species	5	-	5	6	3	8	4	3	4	5	4	4

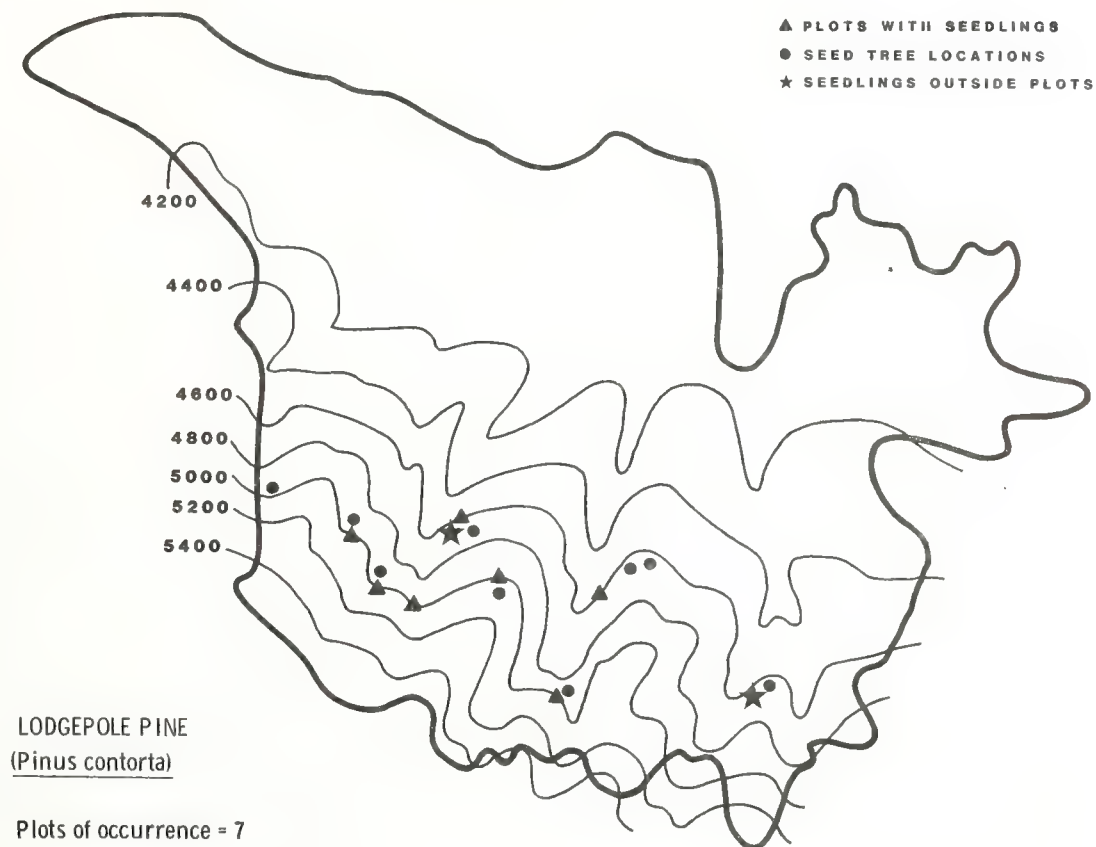
(con.)

Species	Stand number and year											
	21			22			23			24		
	78	79	81	78	79	81	78	79	81	78	79	81
Percent or m ² /0.01 ha												
Bryophytes												
Atrichum selwynii	-	-	-	0.1	-	-	-	-	-	-	-	-
Brachythecium albicans	-	-	-	1.2	.6	-	-	-	-	-	-	-
Bryum caespitium	3.5	1.6	20.8	2.5	5.3	14.2	20.3	9.2	65.5	1.3	1.7	30.7
Ceratodon purpureus	23.5	15.0	33.1	8.8	10.0	12.0	38.2	25.8	1.6	0.5	1.2	19.8
Dicranum scoparium	-	-	-	-	T	-	-	-	-	-	-	-
Funaria hygrometrica	1.1	.4	T	.4	-	-	1.3	.1	-	T	-	-
Leptobryum pyriforme	3.2	-	-	.3	-	.2	1.8	-	-	T	-	-
Marchantia polymorpha	1.1	-	.3	.6	-	-	-	-	-	-	-	-
Minum spinulosum	-	-	-	-	T	-	-	-	-	-	-	-
Pogonatum alpinum	T	-	-	-	-	-	-	-	-	-	-	-
Polytrichum juniperinum	.3	.1	.8	.4	T	4.6	.1	T	.7	T	.1	2.8
Tortula ruralis	-	-	-	-	-	-	-	-	-	-	-	-
Eurhynchium pulchellum	-	-	-	-	-	-	-	-	-	-	-	-
Lichens												
Cladonia sp.	-	-	-	T	-	-	-	-	-	-	-	-
Peltigera canina	-	-	T	.6	-	-	-	-	-	-	-	-
Peltigera leucophaea	-	-	-	.1	-	-	-	-	-	-	-	-
Peltigera spuria	-	-	1.0	T	-	-	-	-	-	-	-	.8
Total number species	7	4	7	12	6	4	5	4	4	5	4	5

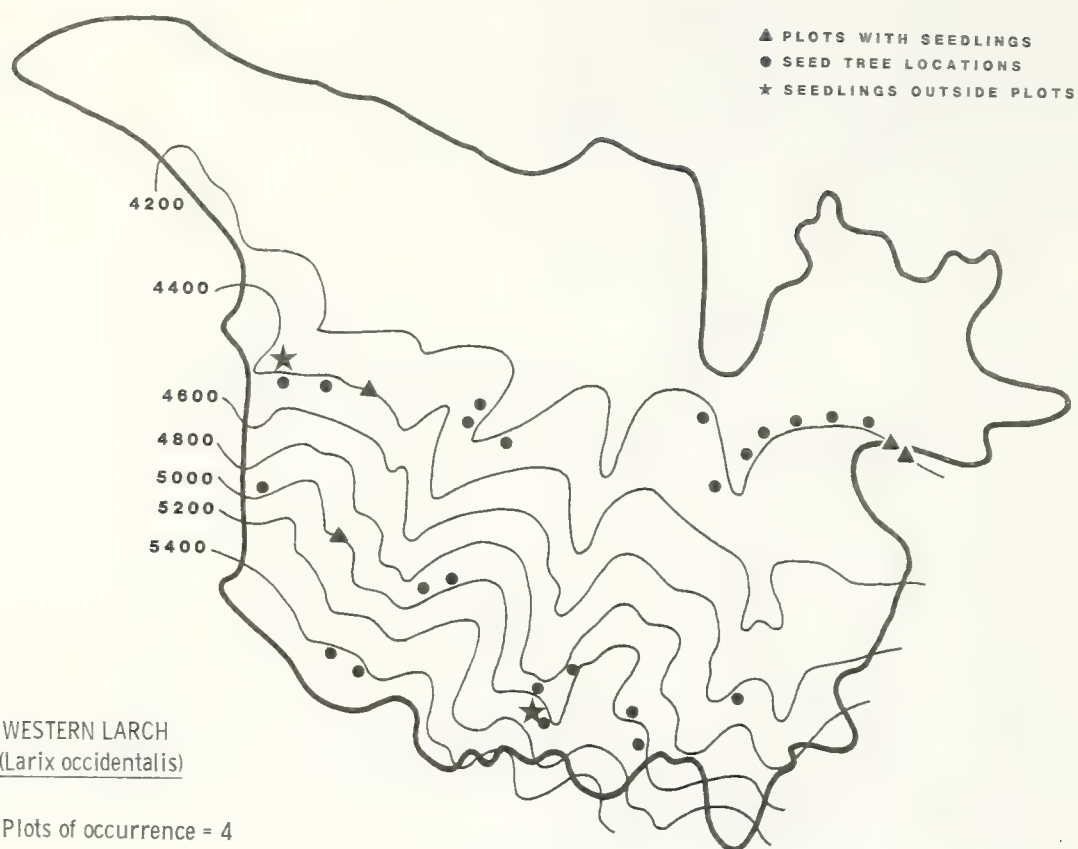
1981 data for stands 16, 21, and 22 based on one transect only (the second one was not found).
 2-position of one transect each in stands 24 and 27 is approximate as the stakes were not found in 1981.
 T = trace.

APPENDIX C

Maps showing tree distribution for each of the major tree species present on the burn. Triangles indicate plot locations where seedlings of that species are present within the plot. Circles indicate plot locations where seed trees of that species were present, and stars indicate the locations of seedlings noted along the transect but not actually within a plot.



APPENDIX C (con.)



APPENDIX D

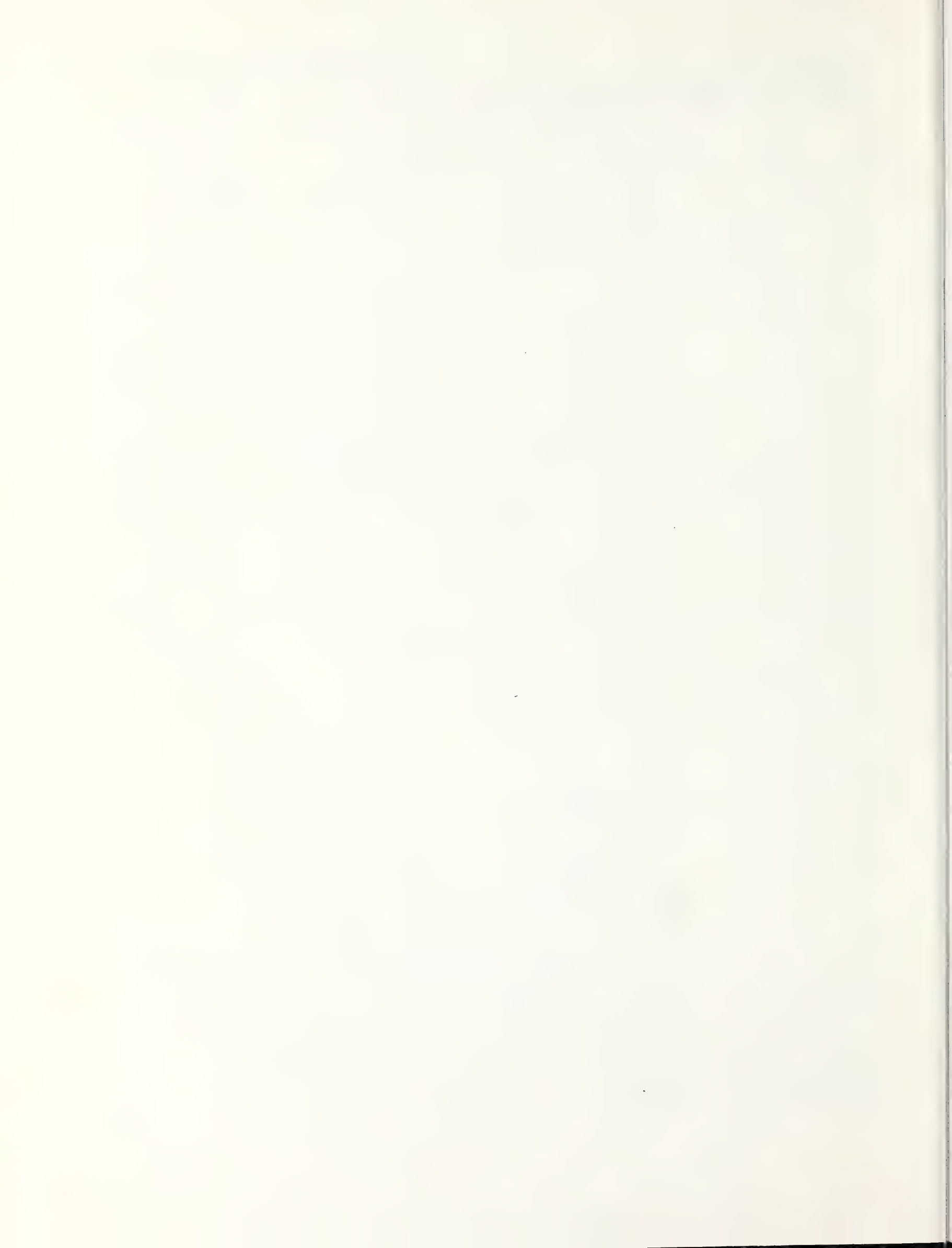
Scientific and common names for trees, shrubs, and other herbaceous vegetation mentioned in the text

Scientific name	Common name
<i>Abies lasiocarpa</i>	subalpine fir
<i>Acer glabrum</i>	Rocky Mountain maple
<i>Achillea millefolium</i>	yarrow
<i>Agropyron intermedium</i>	luna pubescent wheatgrass ¹
<i>Agropyron trichophorum</i>	luna pubescent wheatgrass ¹
<i>Allium cernuum</i>	nodding onion
<i>Amelanchier alnifolia</i>	serviceberry
<i>Anaphalis margaritacea</i>	pearly everlasting
<i>Arctostaphylos uva-ursi</i>	kinnikinnick
<i>Arnica cordifolia</i>	heartleaf arnica
<i>Arnica latifolia</i>	broadleaf arnica
<i>Aster conspicuus</i>	conspicuous aster
<i>Athyrium filix-femina</i>	ladyfern
<i>Berberis repens</i>	creeping Oregon-grape
<i>Bromus inermis</i>	manchar smooth brome ¹
<i>Bromus vulgaris</i>	Columbia brome-grass
<i>Calamagrostis rubescens</i>	pinegrass
<i>Campanula rotundifolia</i>	bluebell
<i>Cardamine pensylvanica</i>	Pennsylvania bittercress
<i>Carex geyeri</i>	elk sedge
<i>Ceanothus velutinus</i>	snowbrush ceanothus
<i>Chimaphila umbellata</i>	princes pine
<i>Cinna latifolia</i>	drooping woodreed
<i>Cirsium arvense</i>	Canada thistle
<i>Collinsia parviflora</i>	blue-eyed Mary
<i>Collomia linearis</i>	slenderleaf collomia
<i>Corydalis aurea</i>	golden corydalis
<i>Dactylis glomerata</i>	lata orchardgrass ¹
<i>Dracocephalum parviflorum</i>	dragonhead
<i>Elymus glaucus</i>	blue wildrye
<i>Epilobium angustifolium</i>	common fireweed
<i>Erythronium grandiflorum</i>	lambstongue fawnlily
<i>Festuca arundinacea</i>	kenmont tall fescue ¹
<i>Festuca occidentalis</i>	western fescue
<i>Fragaria virginiana</i>	Virginia strawberry
<i>Galium triflorum</i>	sweetscented bedstraw
<i>Geranium bicknellii</i>	Bicknell geranium
<i>Geum macrophyllum</i>	largeleaf avens
<i>Glyceria grandis</i>	American mannagrass
<i>Goodyera oblongifolia</i>	Western rattlesnake plantain
<i>Lactuca serriola</i>	prickly lettuce
<i>Larix occidentalis</i>	western larch
<i>Linnaea borealis</i>	Northern twinflower
<i>Mimulus guttatus</i>	common monkey flower
<i>Mitella stauropetala</i>	smallflower miterwort
<i>Montia perfoliata</i>	miner's lettuce
<i>Osmorhiza chilensis</i>	mountain sweetroot
<i>Physocarpus malvaceus</i>	ninebark
<i>Pinus contorta</i>	lodgepole pine
<i>Pinus ponderosa</i>	ponderosa pine
<i>Pseudotsuga menziesii</i>	Douglas-fir

APPENDIX D (con.)

Scientific name	Common name
<i>Pyrola secunda</i>	sidebells shinleaf
<i>Ribes lacustre</i>	Idaho currant
<i>Rosa acicularis</i>	prickly rose
<i>Rosa gymnocarpa</i>	baldhip rose
<i>Rubus parviflorus</i>	thimbleberry
<i>Salix scouleriana</i>	Scouler willow
<i>Smilacina stellata</i>	false-Solomon's-seal
<i>Spiraea betulifolia</i>	white spirea
<i>Symphoricarpos albus</i>	common snowberry
<i>Thalictrum occidentale</i>	western meadowrue
<i>Urtica dioica</i>	stinging nettle
<i>Vaccinium globulare</i>	dampwoods blueberry
<i>Veronica americana</i>	American speedwell
<i>Veronica serpyllifolia</i>	thymeleaf speedwell

¹Commercial hybrid species that were artificially introduced on the area for watershed rehabilitation.



Canopy cover (percent or

Canopy cover (percent or $m^2/0.1$ ha) for species present in ravine stands. T = present as small or scattered individual plants. Stands 1, 6, 8, 10, 11, and 12 were not visited in 1980. Stands 10 and 14 were not visited in 1982.

⁴May include individuals of Taraxacum laevigatum, which was also identified from the area, since field identification is difficult unless achenes are present.



APPENDIX A-1

Canopy cover (percent or m²/0.1 ha) for species present in upland stands. T = present as small or scattered individual plants.

Species	Stand number and year																																							
	78	15 79	82 ^{1/}	78	16 79	82	78	17 79	82	78	18 79	82	78	19 79	82	78	20 79	82	78	21 79	82	78	22 79	82	78	23 79	82	78	24 79	82	78	25 79	82	78	26 79	82	78	27 79	82	
-----Percent or m ² /0.1 ha-----																																								
Shrubs																																								
<u>Amelanchier alnifolia</u>	-	-	-	-	-	.8	-	-	.8	-	T	1.9	-	-	.5	-	-	2.5	T	0.8	1.0	-	-	-	-	-	-	-	-	.8	-	-	-	-	-	.8	-	T	.8	
<u>Physocarpus malvaceus</u>	T	T	1.3	-	-	-	5.0	3.3	14.0	0.8	2.5	.8	9.2	19.2	24.7	-	-	-	T	1.7	2.5	2.5	1.7	5.6	T	1.7	2.7	T	-	.8	T	-	T	-	-	-	T	-		
<u>Rosa gymnocarpa</u>	-	-	-	-	-	-	-	-	-	-	-	-	T	3.3	1.5	T	T	T	T	0.8	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-	.8	-	-	
<u>Salix scouleriana</u>	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	T	0.8	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<u>Spiraea betulifolia</u>	4.2	8.3	2.5	-	T	-	T	.8	-	0.8	3.3	1.7	T	.8	.8	T	.8	.8	T	3.3	3.3	-	-	-	-	4.2	3.3	T	T	.1	T	.8	.8	T	.8	T	T	-	-	
<u>Symphoricarpos albus</u>	-	-	-	-	-	-	T	T	1.7	-	T	T	0.8	2.5	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>Vaccinium globulare</u>	-	-	-	-	T	2.5	-	-	-	-	-	-	-	-	-	-	.8	3.3	-	-	4.2	-	-	-	-	.8	.8	-	-	T	-	-	.8	-	T	5.0	-	-	T	
Grasses																																								
<u>Agropyron trichophorum</u>	-	.8	T	-	-	T	-	-	.8	-	1.7	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<u>Bromus inermis</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.8	
<u>Calamagrostis rubescens</u>	-	3.3	.8	-	10.8	15.8	-	-	5.8	-	9.2	19.2	-	4.2	14.2	-	.8	4.2	6.7	10.8	10.0	-	1.7	3.3	-	5.8	8.3	-	.8	11.7	-	-	-	-	-	2.5	-	-	6.7	
<u>Dactylis glomerata</u>	-	34.2	14.2	-	19.2	17.5	-	35.8	22.5	-	-	4.2	-	.8	.8	-	43.3	10.0	-	-	-	-	21.7	13.3	-	12.5	4.2	-	-	2.5	-	26.7	24.2	-	27.5	6.7	-	8.3	7.5	
<u>Festuca arundinacea</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	T	-	-	1.7	-	-	T	-	-	T	
<u>Festuca occidentalis</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Grass spp.	40.8	2.5	-	10.8	1.7	-	33.3	5.0	-	-	.8	-	2.5	-	-	40.0	.8	-	6.6	-	-	36.7	9.2	-	5.8	5.0	-	-	.8	-	40.8	10.0	-	34.2	-	-	22.5	12.5	-	
Total Grass	40.8	40.8	15.0	10.8	31.7	33.3	33.3	40.8	29.1	-	11.7	25.1	2.5	5.0	15.0	40.0	45.0	14.2	13.3	10.8	10.8	36.7	32.6	17.4	5.8	23.3	12.5	-	1.7	14.2	40.8	36.7	25.9	34.2	27.5	9.2	22.5	20.8	15.0	
Other herbs																																								
<u>Antennaria racemosa</u>	-	-	-	-	T	T	-	-	-	-	-	-	T	-	-	-	-	-	.8	2.5	2.5	-	-	-	-	-	T	-	T	.8	-	-	-	-	-	T	-	-	-	
<u>Arnica cordifolia</u>	T	T	T	T	T	T	T	T	T	1.7	T	T	1.7	T	T	5.0	T	5.8	T	T	1.7	T	T	.8	5.0	T	.8	T	T	T	-	-	-	T	T	T	T	T	T	
<u>Aster conspicuus</u>	-	-	-	-	-	-	T	T	.8	-	-	T	T	T	T	-	T	-	-	-	-	3.3	T	10.8	-	.8	.8	-	T	T	-	-	-	-	-	-	-	-	-	T
<u>Astragalus miser</u>	T	-	-	-	-	-	T	-	-	-	-	-	.8	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	
<u>Berberis repens</u>	0.8	.8	.8	-	-	-	1.7	2.5	5.0	-	-	-	T	1.7	T	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	
<u>Carex geyeri</u>	-	-	-	T	0.8	-	-	-	-	-	T	T	-	T	.8	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	T	T	-	-	T	-	-	
<u>Centaurea maculosa</u>	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.8	-	-	-	-	-	-	-	-		
<u>Clematis columbiana</u>	-	-	-	-	-	-	-	-	-	-	-	-	T	T	.8	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<u>Epilobium angustifolium</u>	T	T	T	T	T	.8	T	-	-	1.7	8.3	5.0	T	T	T	T	T	T	T	T	T	T	T	T	-	-	-	.8	2.5	1.7	T	-	1.7	T	-	T	T	T	T	
<u>Fragaria virginiana</u>	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	T	-	-	.8	T	-	-	-	-	-	-	-	T	T	T	-	-	-	-	-	-	-		
<u>Heuchera parviflora</u>	-	-	-	T	T	T	-	-	-	-	-	-	-	T	-	-	-	-	T	-	.8	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	
<u>Lactuca serriola</u>	T	-	-	-	-	-	T	-	-	T	T	-	T	T	-	T	-	-	T	-	-	T	-	-	-	-	-	-	T	T	-	-	-	-	T	-	-	T	-	
<u>Lupinus sp.</u>	-	T	-	3.3	T	.8	-	-	-	-	-	-	T	-	-	T	T	.8	1.7	0.8	.8	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<u>Montia perfoliata</u>	T	-	-	0.8	-	-	T	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Miscellaneous vegetation																																								
Rock	3.3	2.5	3.3	4.2	2.5	3.3	1.7	0.8	-	-	0.8	-	1.7	10.8	3.3	4.2	1.7	-	15.0	7.5	-	10.0	8.3	3.3	6.7	20.8	6.7	17.5	13.3	8.3	1.7	0.8	-	35.0	29.9	12.5	50.0	46.7	31.7	
Bare Ground	12.5	4.2	.8	5.0	2.5	-	24.2	0.8	-	65.8	17.5	-	67.5	10.0	-	13.3	-	-	8.3	10.0	3.3	13.3	-	-	70.8	14.2	6.7	10.0	16.7	-	19.2	7.5	-	14.2	5.0	-	20.8	5.0	-	
Litter	4.2	19.2	68.3	67.5	44.0	30.8	-	35.0	48.3	3.3	18.3	41.7	0.8	24.2	29.2	5.0	31.7	52.5	21.7	32.5	37.5	0.8	29.2	45.0	-	19.2	39.2	45.0	32.5	30.0	15.8	36.7	45.0	4.2	21.7	51.7	1.7	15.8	31.7	
Moss and lichens	34.2	22.5	4.2	-	12.5	16.7	28.3	14.2	2.5	20.8	36.7	15.8	-	15.0	34.2	23.3	18.3	5.8	20.0	17.5	12.5	32.5	24.2	7.5	-	12.5	15.0	20.0	30.0	25.8	22.5	17.5	22.5	9.2	12.5	10.8	2.5	11.7	10.0	

^{1/} Half of stand 15 was grazed by horses in 1982.

Crane, M. F.; Habeck, James R.; Fischer, William C. Early postfire revegetation in a western Montana Douglas-fir forest. Res. Pap. INT-319. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 32 p.

Development of natural vegetation and seeded grasses on a severely burned Douglas-fir forest area is described for the first 5 postfire years. Results are described separately for ravine and upland sites. Results of special studies of moss recovery and tree seedling distribution are also reported.

KEYWORDS: fire effects, plant ecology, revegetation, burn rehabilitation, forest fire, fuels

Canopy cover (percent or m²/0.1 ha) for species present in ravine stands. T = present as small or scattered individual plants. Stands 1, 6, 8, 10, 11, and 12 were not visited in 1980. Stands 10 and 14 were not visited in 1982.

¹Apparently an escaped cultivar.
²Although some individual shrubs in stands 3, 5, and 6 seem to have characteristics of Rosa woodsii, they are found in the same environment as R. acicularis, they are difficult to distinguish from R. acicularis and they have been included in this table as Rosa acicularis.
³The seeded Agropyron appears to include A. trichophorum, A. intermedium, and hybrids between both species.
⁴May include individuals of Taraxacum laevigatum, which was also identified from the area, since field identification is difficult unless achenes are present.

The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

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